THE ENGINEER

The British Industries Fair at Birmingham.

THE twenty-seventh British Industries Fair opens on Monday next, May 3rd, and will remain open until Friday week, May 14th, at Castle Bromwich, Birmingham, and at Olympia and Earl's Court, London. The Fair will be open to trade buyers and the public every day in Birmingham, from 10 a.m. to 6 p.m., but the public will be admitted to Olympia and Earls Court only on Wednesdays, May 5th and 12th, and on Saturday, May 8th.

The Fair is again very popular with manufacturers, and applications for space have greatly exceeded the aggregate of about one million square feet of space available at the three venues. As usual, the engineering and hardware section is at Castle Bromwich, and lighter industries, including radio, scientific and optical apparatus, are represented at Olympia and Earl's Court. Little, if any, engineering interest attaches to the Earl's Court section, as it is given over to such trades as clothing, foodstuffs, and furniture.

The Birmingham section has been organised by the Birmingham Chamber of Commerce, in collaboration with the Board of Trade, whereas the London section is the responsibility of the Export Promotion Department of the Board of Trade. As befitting the times, much emphasis is being put on the promotion of exports. The combined effect of improvements in manufacturers' ability to fulfil orders and of a decline in the sellers' market for many export industries now makes it more than ever necessary that the inventive and technical skill of British industries shall be displayed to the best advantage, and that overseas markets shall be expanded and new markets developed. The keen desire of manufacturers to take part in the Fair is evidence of their wish that overseas buyers shall see the latest products designed to that end.

Judging from the Fair catalogues and from descriptive notes received from exhibitors up to the time of going to Press, we must add that the heavy engineering industries are far from being fully represented. Indeed, each year there seem to be fewer and fewer engineering firms showing their products, although there is a proportionate increase in the space occupied by makers of hardware, engineering accessories and semi-manufactured raw materials. However, we do not want to create any impression that the Fair is one without importance for engineers. It is of interest to them. There are still very many exhibits that engineers who go to the Fair will have been glad to examine. We have endeavoured to bring together in the pages of this Supplement and in the accompanying issue of THE ENGINEER brief descriptions of the more novel and interesting of these engineering and allied manufactures. Articles in succeeding issues will continue the account.

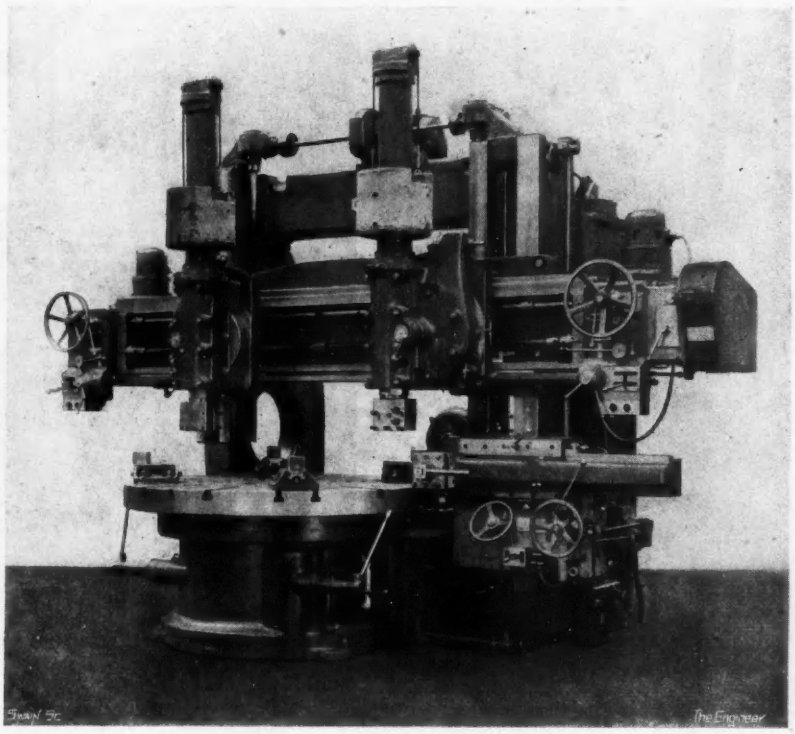


FIG. 1—BORING AND TURNING MILL—CRAVEN

CRAVEN BROTHERS (MANCHESTER), LTD.

The heavy double-column, vertical boring and turning mill illustrated in Fig. 1 is to be seen upon the stand taken by Craven Brothers (Manchester), Ltd., Reddish, Stockport. This machine is fitted with two tool saddles on the cross slide, and an independent side-turning head which is mounted on the right-hand upright. With a worktable 6ft in diameter the machine is designed to accommodate work up to 6ft 3in diameter and 4ft high.

The table rotates on a central spindle and a vee-type white-metal-lined annular track. Both the spindle bearings and the track are flood lubricated by pressure feed from a filtered supply of oil. The machine is driven by a 25 h.p. motor, and a twelve-speed gearbox gives table speeds of 1·5 to 30 r.p.m.

Each cross slide saddle has a balanced octagonal steel ram and is arranged with independent horizontal, vertical and angular self-acting feeds. Each cross-slide has means of rapid power adjustment. Swivel slides permit angular setting of each ram up to 30 deg. to either side of the vertical centre line. The right-hand saddle is arranged for taper turning through a geared connection between the horizontal and vertical feeds. The degree of taper is controlled by change gears and a swing frame at the end of the cross slide.

The balanced side-turning head is fitted with a square cast iron ram having a four-position revolving-turret toolholder. Vertical feed of the side head and horizontal feed of its ram are controlled through an independent gearbox. It incorporates means of rapid power adjustment for both motions.

All the motions of the machine are controlled by push-button switches, and interlocks ensure that all vital parts are supplied with oil before the main motor can be started.

DAVID BROWN AND SONS (HUDDERSFIELD), LTD.

Amongst the well-known range of gear and power transmission equipment made by David Brown and Sons (Huddersfield), Ltd., is to be seen a machine for testing gear materials and lubricants. This machine has been developed by the company for its own purposes and is known as the self-aligning disc machine. The principle upon which it works

is not a new one but incorporates a number of improvements based on twenty years' experience.

The machine was developed to enable an assessment to be made of the behaviour of contacting surfaces or to test lubricants, from results obtained with comparatively simple and inexpensive specimens. In it the peripheries of two discs, rotating at either equal or different peripheral speeds, are pressed into contact with each other under a predetermined load. Apart from determining the ultimate failure loads of materials and oils, the machine serves an additional purpose in that the coefficient of friction between the discs under any operating conditions can be determined at any particular instant, from consideration of the torque required to drive the machine and the force with which the discs are held together.

The arrangement of the machine is shown in the photograph we reproduce below (Fig. 2). A movable disc is supported by two self-aligning bearings in pivoted links. The mechanism for imposing the load of the movable disc on a fixed disc comprises a twin bell-crank lever, the load being transmitted through the short arm of the crank lever and a corresponding adjustable strut to each self-aligning bearing. The direction of loading is horizontal and balance is ensured by a jockey weight suspended centrally between the lever arms from a carrier. This carrier is supported on two balls, which register in dimples on the levers. The machine is driven by one of the firm's "Motogears," giving a reduction of 6 to 1 from the motor to the input shaft.

The disc machine has two main functions. It may be used with a "standard" lubricant to test the load capacity or coefficient of friction of any particular combination of materials; or with a "standard" material combination to test a lubricant.

Two discs made of 4¼ per cent nickel-chromium steel, heat-treated to give a tensile strength of 100 tons per square inch, form the standard material combination for spur, helical and bevel gear contact conditions, and one disc of centrifugally cast phosphor bronze and one of 2 per cent nickel molybdenum case-hardened steel the standard representation of worm gears.

It is pointed out that test results can be assessed only against a background of considerable experience with the machine.

Failure of a metal is usually shown by the progressive developing of "pits" on the periphery. Rarely is a material found to fail by excessively rapid wear. Failure of a lubricant leads to partial welding or scuffing of the contacting surface of the discs, resulting in a marked increase in the torque required to drive the machine and frequently causing the overload release to stop the motor.

The effect of surface finish, as may be expected, is considerable, and for that reason contact surfaces are finished by fine grinding, followed in some cases by honing, to produce surface finishes within a clearly defined range.

The difference between the peripheral speeds of the two discs is the velocity of each surface relative to the other at the line of contact and is therefore the "sliding velocity." The peripheral speed of each disc is the same as the speed with which the contact line moves round the periphery of the disc; this speed is conventionally called the "rolling velocity." The ratio of the sliding velocity to the rolling velocity on either surface is called the "slide-roll ratio" for that surface. If the peripheries of the discs move in the same direction at the line of contact, the slide-roll ratio is negative for the slower of the two surfaces and positive for the other.

Procedure for testing fatigue and wear resistance of combinations of possible gear materials or the comparative load-carrying capacity of gear lubricants is basically similar in that in both cases it consists of subjecting discs—connected by gears or sprockets so as to represent either spur-and-bevel or worm gear conditions—to increasing loads until material or lubricant failure results.

In connection with the wear resistance of gear materials, the radial wear of the discs is measured after each period of load application. This is done by forming the discs with two reference bands on which a sensitive gauge can be located to enable the difference between the radius of the bands and the working surface to be determined. It is stated that the commonly used gear materials and lubricants do not usually show more than a few ten-thousandths of an inch of wear in the course of a test.

HANCOCK AND CO. (ENGINEERS), LTD., AND WELDCRAFT, LTD.

New plant exhibited on the stand of Hancock and Co. (Engineers), Ltd., Progress Way, Croydon, Surrey, includes a light, portable, oxygen cutting machine designed for parting off pipes from 4in diameter and upwards. This machine is hand driven and it can be seen in its operative position on a pipe in the photograph we reproduce in Fig. 3.

The burner can be set to cut at right angles or at angles of up to 45 deg. to the centre line of pipe to form a bevelled edge. It is mounted on a four-wheeled carriage, on which it is carried right round the circumference of the pipe during the cutting operation. In its working position the carriage is held, with its four wheels pressed firmly against the surface of the pipe, by an endless length of duplex roller chain, encircling both pipe and carriage. The chain passes over a sprocket mounted on a shaft in a crosshead on the carriage. This crosshead

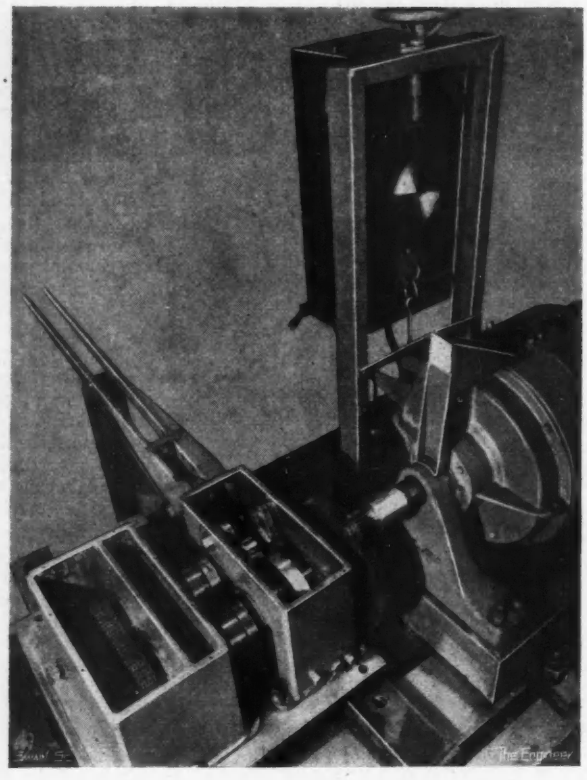


FIG. 2—SELF-ALIGNING DISC MACHINE—DAVID BROWN

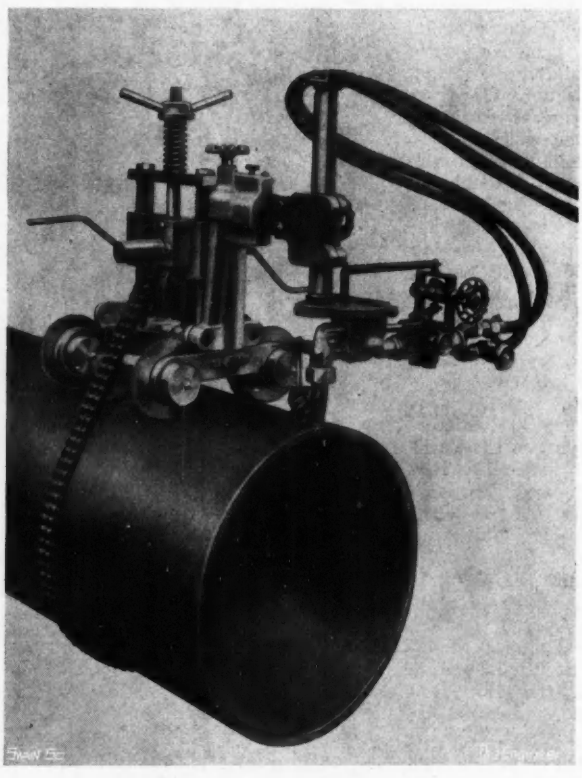


FIG. 3—PIPE-CUTTING MACHINE—HANCOCK

is movable between two vertical columns on the carriage, the tops of the columns being rigidly connected by a tie plate. Fixed in the centre of the crosshead, and extending upwards through the tie plate, is a threaded drawbar. A heavy coil spring held between an adjusting nut on the end of the drawbar and the tie plate is compressed as the nut is screwed down. This action exerts an upward force on the crosshead and imposes the necessary carriage-holding tension on the roller chain.

In operation the sprocket is turned through a worm and worm wheel by handles on each side of the crosshead to drive the carriage, through the medium of the roller chain, round the circumference of the pipe. The bracket which supports the burner on the carriage incorporates means of adjustment for positioning the nozzle relatively to the pipe being cut. In order to maintain the burner at a constant distance from the pipe, particularly when cutting bevels, the burner is arranged to float and rides on a wheel kept in contact with the pipe by spring pressure.

Equipment made by an associated company, Weldcraft, Ltd., also to be seen upon the stand, includes the "Bronzecraft" range of low-temperature welding rods and "Hardcraft" hard surfacing rods. This company is now manufacturing under licence in this country the "Sight Feed" acetylene generator, the arrangement and working of which can be seen in the drawing and photograph we reproduce (Figs. 4 and 5).

It consists of three principal parts—a carbide container incorporating the feed mechanism, a generating tank, and a flash-back arrester.

The carbide container comprises a "Pyrex" glass cylinder in which the pressure of the gas generated in the tank is regulated

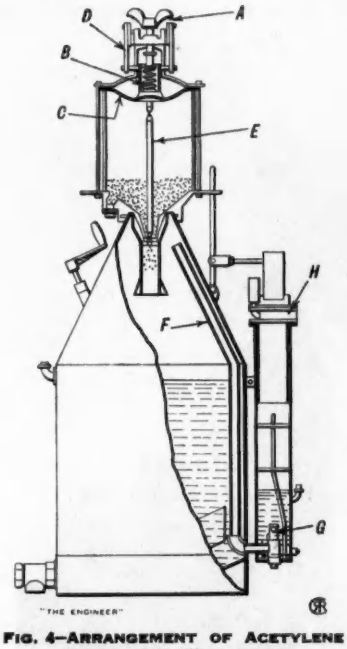


Fig. 4—Arrangement of Acetylene Generator—Weldcraft

by the feeding mechanism. In this mechanism the regulating screw A, controlling the pressure of the spring B on the diaphragm C, is locked or released by movement of the lever D. The diaphragm has depending from it a valve rod E which controls the rate of feed of carbide through an orifice at the bottom of the container. To operate the generator the locking lever is lifted to release the feed mechanism, and this movement lowers the feed valve rod to permit a controlled flow of carbide to fall into the water in the tank. When sufficient gas has been generated to reach the operating pressure set by the regulating valve the pressure reacts on the diaphragm, which is raised. Upwards movement of the diaphragm lifts the valve rod and reduces the size of the feed orifice to decrease the rate

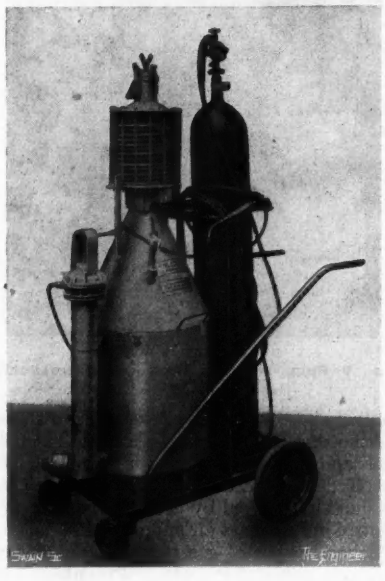


Fig. 5—Acetylene Generator—Weldcraft

of carbide supply into the tank. The rate of feed is thereby automatically controlled by the gas pressure on the diaphragm, and only sufficient carbide is fed into the water to replace the gas drawn off.

Acetylene gas generated in the tank is drawn off through the pipe F and a ball check valve G in the bottom of the flash-back arrester. The gas is washed in the water in the arrester and, after passing through baffles and a filter, the moisture in it is removed in a condensation chamber before it is released into the service line through the valve H. If at any time the valve H is closed or gas is not being used the back-pressure of gas on the diaphragm automatically stops all flow of carbide and generation ceases.

Copper Development Association

A number of panels on the stand taken by the Copper Development Association, Grand Buildings, Trafalgar Square, London, W.C.2, have been arranged to show the wide range and variety of applications for which copper and its alloys are used in many important branches of industry.

On one of the panels designed to show unusual specimens of copper in fabricated form is to be seen copper foil, 0·0005in thick, 6in wide. This foil was produced in commercial quantities and to exacting requirements by cold rolling. On an adjoining panel a deep spinning illustrates the high degree of manipulation to which copper can be subjected. This spinning was made from a flat copper disc, 22in diameter by 19 S.W.G. and in its finished form is a vessel 18in deep with a diameter of 3in at one end and 10in at the other.

A piece of four denier gauze, such as is used in the papermaking industry, is exhibited to show how brass, bronze and other copper alloys can be drawn into fine wire and woven. In the example shown the warp is of bronze wire and the weft is of brass wire, the seams having been made by butt welding each strand of the warp.

Incandescent Heat Company, Ltd.

A small completely automatic gas producer is one of the more interesting and novel exhibits shown by the Incandescent Heat Company, Ltd., of Birmingham, and is described in some detail below. In addition, the Incandescent Group's stand includes exhibits of the products of its four associated companies, Metalectric Furnaces, Ltd., Controlled Heat and Air, Ltd., Selas Gas and Engineering Company, Ltd., and Metal Porcelains, Ltd. A Metalectric exhibit of considerable interest is that company's "Thermonic" induction heating equipment, which is shown continuously in operation at the Fair. Low-temperature ovens, by Controlled Heat and Air, Ltd., are represented by a working continuous paint dryer, whilst gas and oil burners, foundry equipment and castings are shown by Selas Gas and Engineering Company, Ltd. The products of Metal Porcelains, Ltd., are represented by samples of frits, oxides and finished enamelware.

Known as the A.G.M. (automatic gas machine), the small gas producer referred to above is designed to convert bituminous coal, anthracite, coke, charcoal and other solid fuels into hot transmittable gas. It has a self-regulating feed mechanism, automatic ash discharge and other novel features, and is completely self-contained. When using bituminous coal, gas of about 150 B.Th.U. value per cubic foot, at n.t.p., is claimed to be generated at any desired rate from 250 lb to 50 lb per hour (25 therms to 5 therms). The rate of gasification can be quickly and easily controlled, either manually or by remote control from pyrometric gear mounted

Fig. 6—Automatic Gas Machine—Incandescent Heat

on the furnace or other apparatus fed by the machine. The machine can be used continuously or intermittently; after an all night shut-down, high-quality gas can be generated within a few minutes of starting up. Reducing, neutral or oxidising furnace atmospheres, appropriate to the class of loading, may be maintained throughout a temperature range of 400 deg. to 1500 deg. Cent.

Photographs reproduced in Figs. 6 and 8 show the general appearance of the machine and the feed control mechanism. Its

working may be followed by reference to the sectional view, Fig. 7. As already mentioned, there is a self-regulating mechanical fuel feed and automatically controlled ash discharge gear. There is also an automatic vaporiser, to prevent formation of excessive clinker and the adhesion of ash to the producer walls. Two electric motors drive respectively the fuel feed and the fuel agitation and ash discharge mechanisms, whilst a third drives the blower.

Control of the fuel feed is effected by a fuel level feeler gauge continuously raised and lowered over the fuel bed, making contact with its surface at each stroke. The gauge is connected by link and ratchet mechanism to a rotary fuel feed drum situated at the base of the fuel hopper. When the level falls below the proper height, the gauge takes a longer stroke, and the ratchet mechanism, coming into effect, turns the drum at each stroke until the fuel bed reaches its proper height. At this point the stroke of the feeler gauge is insufficient to operate the ratchet mechanism and the fuel feed is consequently cut off.

A water jacket around the combustion chamber provides the necessary blast saturation and prevents clinker formation. The water vapour so generated is mixed with the air supply from a centrifugal fan, the mixture then passing to the fuel bed. A ball float valve keeps the jacket water level constant.

The grate is mechanically rotated, so as to produce a constant shearing of the fuel bed, and this action, together with the effect of a vertical fixed "poker," is said to eliminate channelling. Ploughs on the rotating grate direct the ash to a discharge port, beneath which is a mechanically driven ash extraction screw. Ingenious use is made of a thermo-couple incorporated in the "poker," which registers any drop in temperature caused by an increase above the normal ash level, and through a relay sets in operation the motor driving the grate and ash screw. The motor remains switched on until the hot zone falls to the correct level, when the thermostatic control again comes into operation to switch the motor off. It is therefore clear that both fuel and ash levels remain constant, irrespective of the rate of gasification, which can be quickly changed by use of a single master control on the blast air supply.

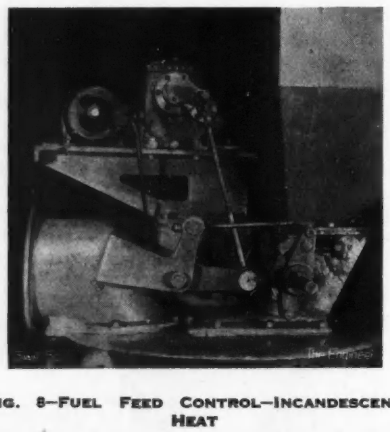


FIG. 8—FUEL FEED CONTROL—INCANDESCENT HEAT

Several types of gas offtakes and burners are available for various applications. Other standard equipment includes waste heat recuperators, acting as heat exchangers to extract heat from the furnace waste gases and to transfer it to the combustion air, thereby increasing the efficiency of the gas producer. Such recuperators may be of single or double-pass construction, of mild steel or nickel-chromium steel, according to the furnace temperature operating range.

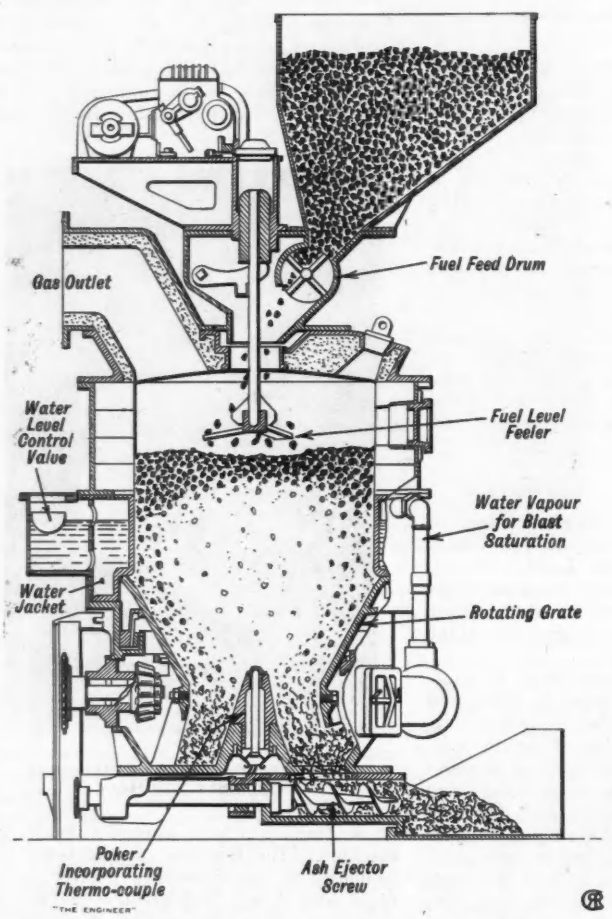


FIG. 7—AUTOMATIC GAS MACHINE—INCANDESCENT HEAT

The machine weighs 1 ton 17 cwt, but is supplied as a complete unit and requires no special foundations. A water supply of up to 20 gallons per hour is required.

I.T.D., LTD.

New developments based on the addition of equipment to "Stacatruc" fork-lift trucks are shown for the first time in an outside display by I.T.D., Ltd. (Industrial Truck Development), of 142, Sloane Street, London, S.W.1. These petrol-driven trucks are made in two models, the one designed to lift a load of 2 tons to a height of 9ft, and the other a load of 3500 lb to a height of 12ft. The attachments concerned are a rotary tilter, converting the truck into a transporting and handling machine for use in steelworks, foundries and engineering shops, and a hydraulically operated mobile shovel. In addition, the firm is exhibiting "Stacatrailers" in 2-ton and 3-ton models; the "Stacascoop," a digging attachment for handling sand, coke, grain and other loose materials; and finally, the "Aeroloader," for handling aircraft loads at airports.

A "Stacatruc" converted for use with the rotary tilter is illustrated in Fig. 9. The equipment consists of a heavy support casting bolting directly to the standard roller bracket assembly which moves inside the truck mast channels, and which is therefore capable of being lifted or lowered vertically to the full extent of the mast (9ft or 12ft, according to the basic truck model). The mast can also be tilted forward 3 deg. or backward 10 deg. The support casting forms the bed-plate for a Lockheed hydraulic motor, which is coupled to a worm drive fitted to a revolving head, carried on roller bearings. The standard carriage and fork assembly is carried by the rotating head, which can be rotated full circle in either direction and stopped in any position at will.

FIG. 9—ROTARY TILTER—I.T.D.

Designs of locking gears to secure bins, skips or ladles to the lifting forks of the rotary tilter are available for loads up to 1 ton at a distance of 18in from the heel of the forks. The equipment is therefore capable of many applications and largely eliminates the neces-

sity for manhandling, particularly when items such as small forgings, ingots, castings or liquids are required to be lifted into hoppers, furnaces or moulds above ground level in confined spaces and gangways.

British Insulated Callender's Cables, Ltd.

Prominent amongst the exhibits shown by British Insulated Callender's Cables, Ltd., 72-78, Fleet Street, London, E.C.4, is a group of three electric resistance welders. The first of these, the well-known pedal-operated spot welder No. 94, is a general-purpose machine rated at 20kVA for welding mild steel up to $\frac{3}{8}$in total thickness or aluminium up to $\frac{1}{4}$in total thickness. In addition a continuous spot welder and a bench type butt welder, No. 109, are on view.

Model 109 is a bench type flash welder specially suited for welding steel strip such as bandsaws, and the standard clamps (which are provided with alignment guides) are arranged to take strip up to a maximum width of 3in. Other clamps can, however, be fitted to make the machine suitable for almost any type of flash welding within its capacity. The base of the machine (Fig. 10) is a cast iron cover plate, which carries all the operating gear and provides a foundation for the transformer and contactor, the whole being supported on a fabricated frame, enclosed by a louvred sheet metal case.

Movement of the right-hand clamp, which is carried on a cast iron saddle, is by means of a cam actuated by a hand lever projecting on the right of our illustration. The cam is clamps to an amount suitable for normalising the smaller sections. The transformer primary winding is tapped to give a range of four secondary voltages, the lowest of which can be arranged to give a specially low voltage for normalising if this should be required.

Control of the welding current is by a magnetic contactor fitted inside the sheet

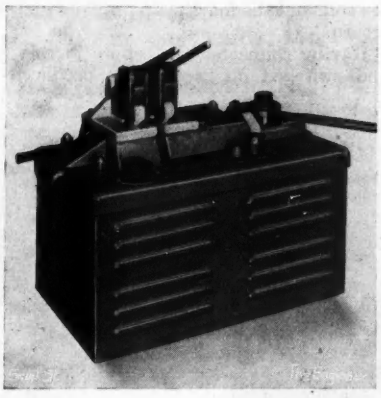


Fig. 10—Flash Welder—B.I.Callender's

metal case and closed by a push button mounted on the cover plate. On completion of the weld the contactor is opened by a saddle-operated limit switch.

Tabulated herewith are the main characteristics of the standard machine.

A small part of the display on this stand is devoted to high-frequency heaters, welders and soldering machines. Working models are on show to demonstrate the company's activities in railway electrification. The exhibits also include vertical runs of "Sandwich" cables set up so as to demonstrate their non-bleeding qualities under high ambient temperatures.

Standard Model 109 Flash Welder

Rating	30kVA
Welding range in mild or medium carbon steels	1in × 0·015in to 3in × 0·064in
Maximum secondary current	7500A
Upset pressure	1000 lb approx.
Approx. size, excluding operating handle	24in × 15in × 12in high
Approximate weight	2 cwt

ment of the lever behind the normal starting position increases the gap between the

Alfred Bullows and Sons, Ltd.

The principal exhibit on the stand of Alfred Bullows and Sons, Ltd., of Long Street, Walsall, Staffs, is one of the firm's new three-cylinder, two-stage, air-cooled compressors, a drawing and photograph of which we reproduce (Figs. 11 and 12). It has a displacement of 72 cubic feet of air per minute at its normal speed of 960 r.p.m., and is designed for a maximum working pressure of 125 lb per square inch. The model on exhibition is driven by a directly coupled 15 h.p. electric motor mounted on a common bed-plate.

The machine has two low-pressure cylinders, one on each side of a centrally disposed high-pressure cylinder. With a stroke of 3in, each of the low-pressure cylinders has a bore of $5\frac{1}{4}$in, and the high-pressure cylinder has a bore of $4\frac{1}{2}$in.

The crankcase of the compressor is a rigid aluminium alloy casting with a detachable sump. It is fitted with an exhalation valve designed to prevent the entry of foreign matter and allow a slight vacuum in the crankcase whilst the machine is operating. Cast aluminium bearing covers, which have steel retaining plates to hold the outer races of the main bearings, are accurately bored to receive the bearings and spring-loaded synthetic rubber oil seals. A cast "Meehanite" crankshaft rotates in heavy-duty ball bearings on the flywheel side and roller bearings on the drive side. The connecting-rods are H-section duralumin stampings and are fitted with steel-backed white metal strip type renewable shells in the big ends and phosphor bronze bushes in the little ends. The cylinders and cylinder heads of alloy cast iron have deep radiating fins to provide a large effective cooling surface. An annular air intake belt is cast integral with each cylinder. An inlet valve seating is machined in each cylinder neck.

Each of the cylinders is fitted with the maker's own design of high-speed combined suction and discharge valve gear. This valve gear consists of a thin ring type inlet valve, which is located in machined spigots in the cylinder neck and controls the supply of air from the inlet belt round the cylinder. The inlet valve works in conjunction with a controlled lift discharge valve of chrome-vanadium steel located on its seat by a cast iron guard, fitted with three coil return springs and small damping pistons. The

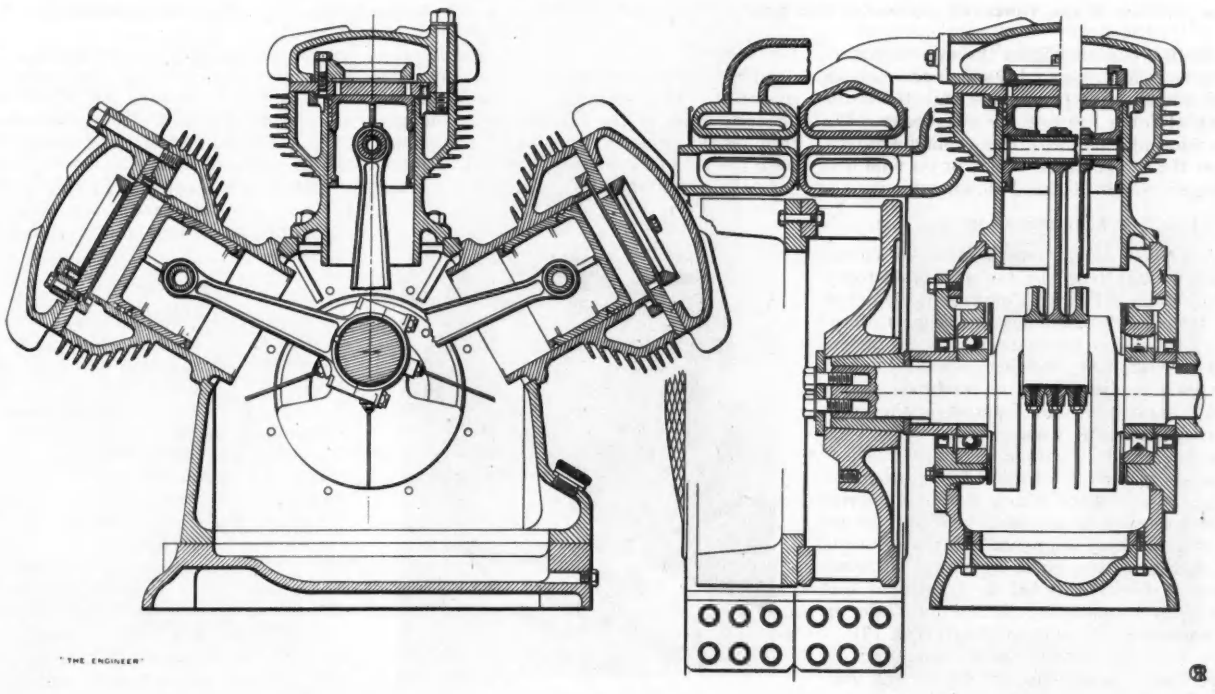


Fig. 11—Arrangement of Three-Cylinder Air Compressor—Bullows

separation of the inlet and discharge port prevents the transfer of heat to the incoming air and makes the whole of the cylinder head available for cooling the incoming air. Noise and wear-producing impact between each delivery valve and its guard is eliminated as the valve movement is restricted by the damping units.

The compressors have built-in intercoolers and aftercoolers, consisting of two annular banks of gilled tube heat exchangers arranged round a double-entry open-discharge centrifugal fan on the end of the crankshaft. Air from the first-stage cylinders is transferred to the high-pressure cylinder through the innermost bank of tubes, and the high-pressure air is delivered after passing through the outer bank of tubes forming the aftercooler. We are informed that with this cooling arrangement the temperature of the air on final discharge is within 20 deg. Fah. of ambient.

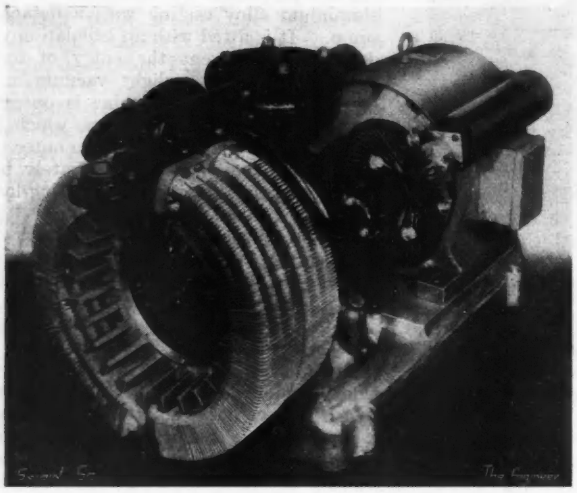


FIG. 12—TWO-STAGE THREE-CYLINDER AIR COMPRESSOR—BULLOWS

ENGLISH ELECTRIC COMPANY, LTD.

A representative cross-section of equipment manufactured by the various factories of the English Electric Company is displayed on this stand. Air blast switchgear, fusegear, fractional horsepower motors, meters and instruments, welding equipment and domestic appliances are represented.

An item of general interest is the commercial ignition tester, which has been developed to help garage mechanics to diagnose every kind of ignition fault, using the power supply of the vehicle itself. A description of the test set in a form produced for use in military establishments and the principle of operation was given in THE ENGINEER, June 14, 1946, pages 542–3. In general, this description applies to the ignition tester in its commercial form as exhibited (Fig. 13).

A full description would therefore be superfluous, but briefly, the instrument comprises a self-contained test set housed in a metal case, 11½in high by 8in wide by 18in long. It can be used for a complete examination of the ignition system of any sort of internal combustion engine while the engine is running and, if necessary, while the vehicle is actually on the road. Every kind of plug fault, including wide and narrow gaps, incipient failure of insulation, as well as troubles due to tracking in the distributor, contact breaker faults, or defects in the primary condenser, can be quickly and clearly diagnosed by the characteristic shape of a cathode ray trace.

The screen of the c.r. tube and the control knobs are mounted in the front of the instrument and are protected by a hinged cover, shown open in Fig. 13. A single multi-core lead connects the tester to the engine and is stored, when not in use, in a pocket set in the back of the case. The multi-core lead has four tails, one of which is clipped to No. 1 plug; the second is attached to the "circuit breaker" terminal of the coil, carrying primary impulses to the c.r. tube; the third clip goes to the switch terminal of the coil, and the fourth clip provides an earth return.

Having connected the set up in this way and switched on, a trace is produced on the cathode ray tube screen, showing the complete firing cycle of all the cylinders in sequence. The shape, height and general characteristics of the row of peaked images forming the trace can be simply interpreted with the help of a booklet provided with the set. Control of amplitude and width of trace is provided, and there is an ignition loading device, which allows the operator to reduce the energy of the ignition circuit, simulating the conditions encountered, for instance, in hill climbing. The set can be used on engines with any number of cylinders and it can operate on 6V, 12V or 24V d.c. circuits.

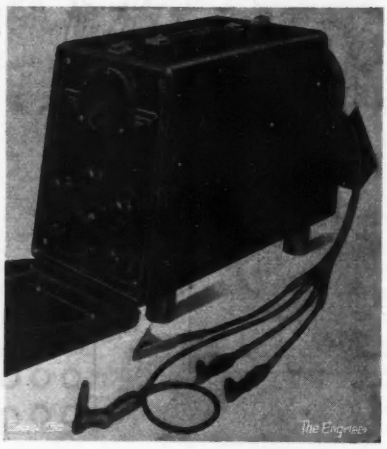


FIG. 13—IGNITION TESTER—ENGLISH ELECTRIC

Fractional horsepower motors are made at the company's Bradford and Liverpool works and the twelve examples displayed are typical of the range which extends from $^1/_{20}$h.p. to 1 h.p. and comprises motors suitable for operation on single-phase, two-phase and d.c. supplies. Reduction gearing is available for most of these motors, but without this accessory, a.c. machines, with speeds ranging from 720 r.p.m. (using an eight-pole frame) to 2800 r.p.m., are available.

This range of f.h.p. motors has recently been completely redesigned. As an alternative to the standard insulation, glass fibre insulation is used for machines intended to run in high-ambient temperatures, such as those associated with soot blowers on boiler installations. Most of the motors in this range are available either with standard deep-groove ball bearings or with steel-backed Babbitt-metal sleeve bearings. Rigid-base mounting, resilient ring mounting or resilient base mounting are available with most of the machines. Thermal overload protection with automatic or manual resetting can be provided as an extra.

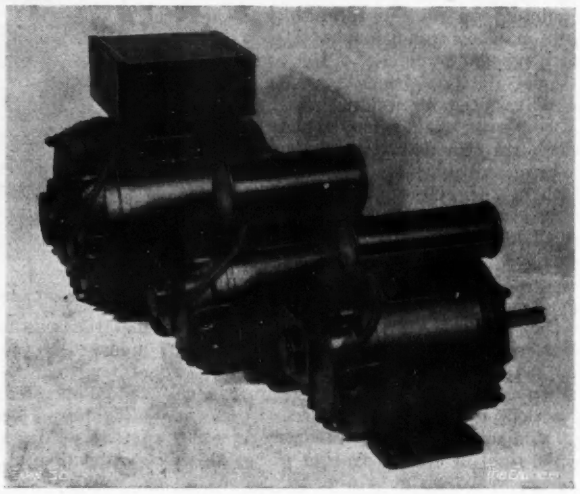


FIG. 14—SINGLE-PHASE F.H.P. MOTORS—ENGLISH ELECTRIC

The motors illustrated in Fig. 14 as being typical of this range are single-phase, capacitor-start, induction-run, sleeve bearing machines.

J. BROCKHOUSE & CO., LTD.

Amongst the familiar range of products of the group of companies forming the Brockhouse organisation is to be seen the "Polygon" toolbox made by Thomas Chatwin and Co., of Great Tindal Street, Birmingham. This accessory has been developed to permit the production of hexagons, squares, octagons or other polygon shapes on workpieces in capstan lathes.

As can be seen from the illustration, Fig. 15, the body of this toolbox is integral with a shank designed to fit into the turret of a capstan lathe. In the base is a machined slide on which the tool holder is mounted. This slide is moved transversely by the action of a hardened and ground rotating ring cam running in a large ball bearing in the front plate of the toolbox. The inside face of this ring cam is contoured to correspond with the form it is required to produce on the workpiece. Attached to the tool-holder slide is a hardened and ground follower which, with the slide, is spring loaded against the internal cam face. It will be seen that as the cam is rotated it causes the tool holder, through the follower, to reciprocate in accordance with the cam contour.

In operation a catch pin projecting from the nose of the capstan lathe engages with a driving dog on the ring cam holder. As both the work and the ring cam rotate the cutting tool on the slide reciprocates in relation to the work. This movement of the

cutting tool imparts the required contour to the component.

The ring cams in the box are quickly interchangeable and by the use of suitably shaped cams it is possible to turn flats, squares, hexagons, ovals, &c., with a side-cutting knife tool.

These toolboxes are manufactured in two sizes, the smaller having a shank 1in

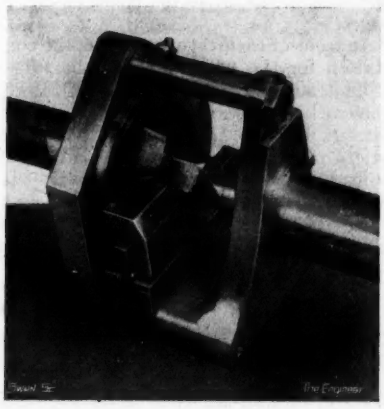


FIG. 15—"POLYGON" TOOL BOX—CHATWIN

diameter and being capable of admitting bars up to 1in diameter. It will cut polygons from ¼in to ⅝in across the flats. The larger size box has a 1¼in diameter shank, admits work up to 1½in diameter, and will machine polygons between ¼in and 1½in across the flats.

The body of the tool holder is bored to accommodate an end cutting tool which can operate whilst the outside circumference of a component is being machined.

SAUNDERS VALVE COMPANY, LTD.

A representative selection of the well-known range of valves and "Safran" pumps made by the Saunders Valve Company, Ltd., of Cwmbran, Newport, Mon, includes a

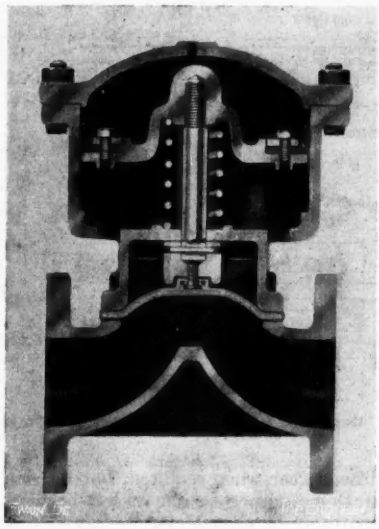


FIG. 16—POWER-OPERATED DIAPHRAGM VALVE—SAUNDERS

piston-operated diaphragm valve, which is shown in section in Fig. 16. This valve has been developed for use where hand operation is inadequate or inconvenient.

In this valve the rod of a large pressure-operated piston, in a cylinder mounted above the body of the valve, is coupled to the top of the diaphragm. The diaphragm is normally held open by a coil spring on the piston-rod and the pressure of the liquid in the pipe line. When a hydraulic or air supply line connected to the upper part of the cylinder is opened to admit pressure into the cylinder the piston is forced down to close the valve.

The large area of the diaphragm actuating piston enables a low-pressure service to close the valve in a pipe line working at a much higher pressure. The main piston can be "floated" in any position in the cylinder to control the flow of liquid in the pipe line.

BRADLEY AND TURTON, LTD.

The totally enclosed self-contained 100-ton moulding press illustrated in Fig. 17 is to be seen in operation on the stand of its makers, Bradley and Turton, Ltd., of Kidderminster. This press, with a table area of 20½in by 28in and a daylight of 22in, is designed to accommodate electric platens 20in by 20in by 2in. The load exerted by the ram is infinitely variable between 20 tons and 100 tons, the closing and return strokes being controlled by a single lever operated valve.

The power unit of the hydraulic system is housed within a sealed supply tank enclosed

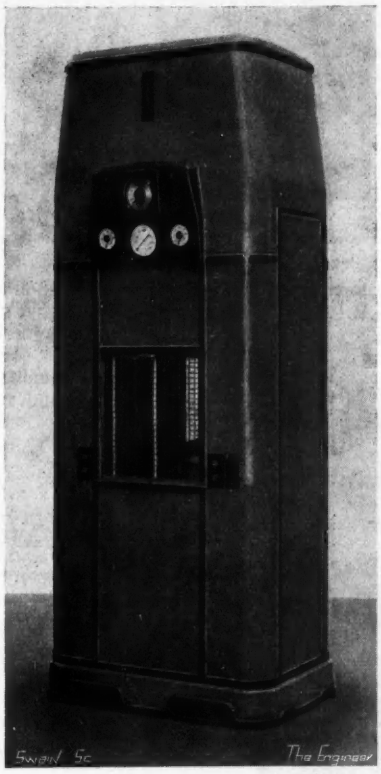


FIG. 17—100-TON PRESS—BRADLEY

in the head of the machine. It consists of a high-speed pump of the sustained pressure type, the delivery of which is adjustable and can be set between 400 lb and 2000 lb per square inch.

The press is fitted with semi-automatic gear for top and bottom ejection, the length of the ejection stroke being adjustable up to a maximum of 4in. Front and back guards fitted within the frame of the press are interlocked and the ram cannot be lowered until the guards are in position.

A dial pressure gauge, two thermometers, and a process timer are grouped with tell-tale lamps on a panel directly in front of the machine operator.

ETHER, LTD.

A comprehensive range of heat control and measuring equipment is being shown by Ether, Ltd., Tyburn Road, Birmingham, whose display includes a variety of electronically operated recorders, controllers and combustion safeguards.

One of the instruments shown for the first time is the Ether "Wide-Strip" recording potentiometer (Fig. 18), which is designed not only for indicating and recording but also for providing on-off, high-low,

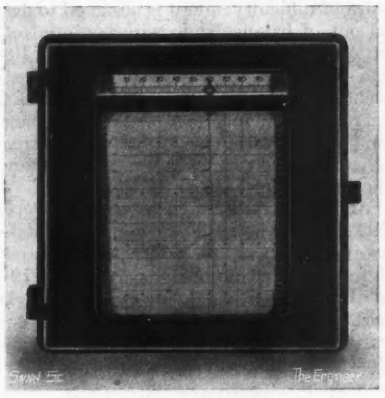


FIG. 18—"WIDE-STRIP" ELECTRONIC POTENTIOMETER RECORDER—ETHER

multiposition proportional control. The readings are independent of external circuit resistance and can be calibrated to measure temperature, millivolts, milliamperes, CO_2, gas flow, &c.

The wide strip potentiometer is electronically operated throughout, which eliminates the necessity for the galvanometer normally associated with this class of instrument. A twin slide wire with a total length of 20in forms the potentiometer element, the two units in parallel being mounted immediately behind the chart. The slide wire forms a track for the carriage holding the recording pen itself, so that no error due to backlash is possible.

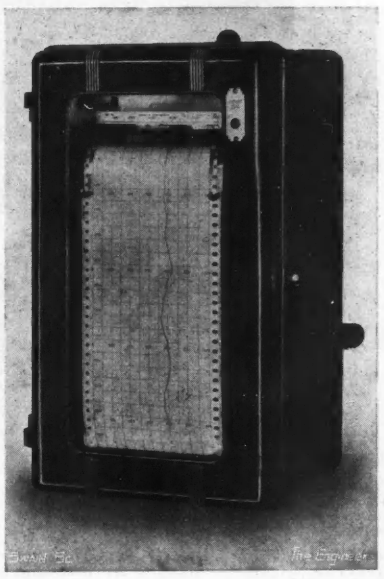


FIG. 19—"INDICORDER" CONTINUOUS CHART RECORDING PYROMETER—ETHER

In operation the d.c. out of balance potential from the slide wire contact is fed into a magnetic inverter which converts the potential into a.c. and at the same time amplifies it. The potential is then passed to an amplifier, emerging in the region of 230V. The final output stage of the amplifier embodies a phase shifting device whence the output is fed into a two-phase motor, which drives

the pen up or down the scale so as to eliminate the out of balance signal received from the slide wire.

While the normal instrument has a speed of travel across the chart of twenty-eight seconds, it is possible for the pen to traverse the chart in as little as two seconds. The instrument can, it is stated, be calibrated for a full-scale deflection of 10mV without difficulty, and it is designed to detect an out of balance slide wire potential of as little as 0·002mV. For scale ranges of 10mV and above the overall error of the instrument is claimed to be of the order of 0·2 per cent. An inherent property of the circuit is that, within wide limits, the external resistance has no effect on the accuracy of the instrument.

Another exhibit is a new version (type L.C.R.) of the well-known "Indicorder" continuous chart recording and controlling pyrometer. This instrument (Fig. 19) is of the chopper bar direct deflectional class, with a chart width of 5in and a chart speed variable between ½in and 6in per hour. Thermocouples, radiation tubes and resistance bulbs are used in conjunction with this instrument over a temperature range of −200 deg. to +2000 deg. Cent. and a full range of electrically operated valves is available to adapt the instrument for the control of gas-oil and other kinds of furnaces.

British Oxygen Company, Ltd.

Exhibits on the stand of the British Oxygen Company, Ltd., are designed to emphasise all sides of the company's industrial activities, including particulars of service facilities.

The equipment to be seen includes a new "Argonarc" welding outfit, which is

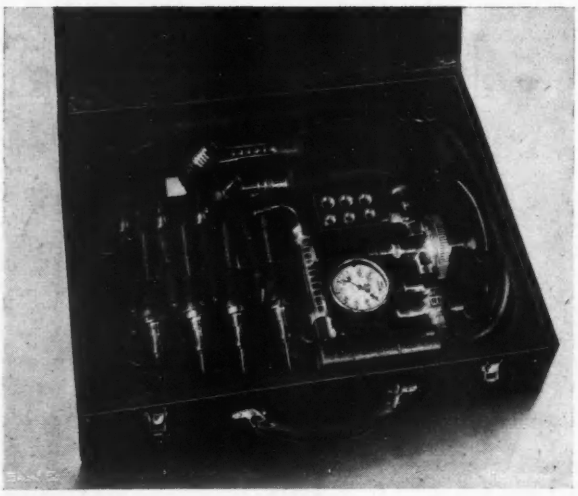


FIG. 20—"ARGONARC" WELDING OUTFIT—BRITISH OXYGEN

suitable for currents up to 150A. In this new outfit (Fig. 20) there are two heads, a large and a small, which are stronger and have better cooling qualities than the earlier models. The "Tufnol" handles now fitted to the heads are stated to have a higher degree of resistance to heat. The Argon head, formerly of copper, is now made of a refractory material and has been modified to permit the use of longer electrodes, which reduce the wastage of tungsten. In order to prevent pressure building up in the tubing slightly larger gas orifices have been introduced in the new set of equipment.

As can be seen from the photograph which we reproduce, the outfit is contained within a compact case and is readily portable.

Westinghouse Brake and Signal Company, Ltd.

A particularly interesting display has been arranged in the outdoor section of the Fair by the Westinghouse Brake and Signal

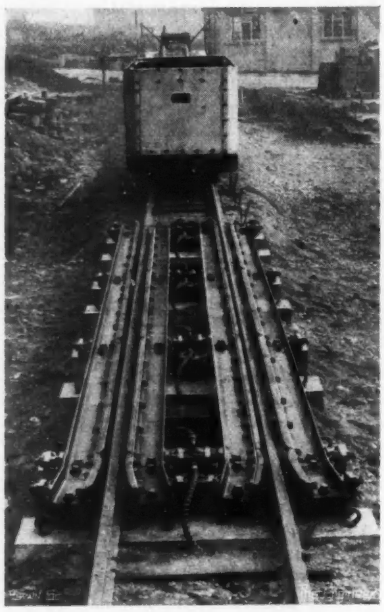


FIG. 21—TUB RETARDER—WESTINGHOUSE BRAKE

Company, Ltd., of 82, York Way, London, N.1, to show the lay-out and operation of a typical automatic decking plant for collieries. This display covers an area of some 3000 square feet, and with the exception of actual pit shafts is complete and similar in every respect to a working installation. Our readers will remember that an automatic decking plant of this type installed at Bold Pit was described in some detail in THE ENGINEER of October 3, 1947. In these plants the whole sequence of tub movements is controlled through pneumatically operated mechanism by one man stationed at the entry to the pit shaft cages.

The lay-out of the exhibit is shown in the drawing we reproduce in Fig. 22. The cycle of tub movements begins at the exit of the hoist, the highest point in the system. From this point empty tubs are released and run by gravity along a single track leading into double tracks to the cages at the pithead. During their journey along the single track the tubs pass over an axle counter which controls the supply of air to an operating cylinder for the points at the entrance to the double track. When a predetermined number of tubs have passed down the track leading to one cage the points are automatically switched to direct the next group on to the track to the other cage.

In front of each cage, adjoining the control station for the whole system, the tubs are stopped and held by skotch blocks (Fig 23) in the tracks. Here, under actual working conditions, the tubs are held until the appropriate pit cage arrives at ground level with a load of full tubs from the depths of the pit. When the cage arrives the gates at each end are opened by automatic means. The group of waiting empty tubs is then pushed forward into the cage by pneumatic rams set between the rails at the pit rear. As the empty tubs pass into the cage they push before them the full tubs which have been raised. The full tubs run out on to tracks on the opposite side of the cage. At the end of a stroke each pneumatic decking ram is retracted and a spring-operated link at its end automatically engages with the rearmost axle of the next group of empty tubs. A tub controller on the outgoing side of the cage allows the predetermined number of full tubs to pass out before arresting the first empty tub.

The full tubs leaving the cages run down a gradient from the pithead and, prior to entering a single-track section, are slowed down by automatic, air-operated retarders on each rail. A typical retarder for very heavy tubs, which acts both on the wheel rim and the flange, is illustrated in Fig. 21. The single track in the demonstration plant leads through an automatic air lock. In an actual installation one of these air locks would, of course, be set on each side of the

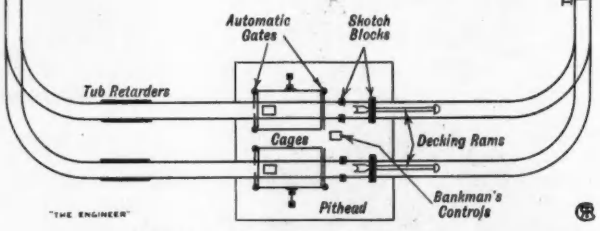


FIG 22—AUTOMATIC DECKING PLANT—WESTINGHOUSE BRAKE

pithead gear when required, but for demonstration purposes one has been built separately to permit easy access for inspection. On their approach to the air lock the tubs pass over an axle counting controller and on to a stop in the lock. When a predetermined number of tubs have been admitted lifting doors at the entrance to the air lock are automatically closed and locked. Swing doors at the exit end of the air lock then open and tubs run out to a controller on a parking section of line leading to an air hoist. The tubs are elevated on the hoist and released on the top of the gradient to recommence their working cycle. It will

be appreciated that the air hoist on which the tubs are raised to the top of the working gradient is not part of the actual equipment, but it represents the medium by which the tubs are elevated and emptied in normal circumstances.

This company also has an indoor stand at Birmingham, on which it is showing examples of its oil-cooled rectifier equipments and metal rectifiers.

Amongst these exhibits is to be seen a ten-way rapid ticket-printing and issuing

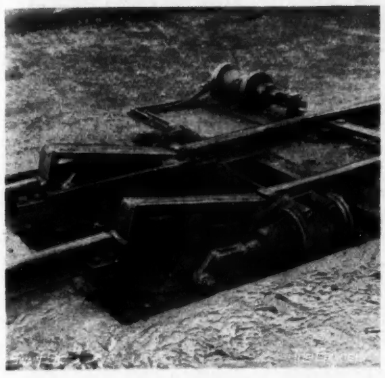


FIG. 23—RAIL SKOTCH BLOCKS—WESTINGHOUSE BRAKE

machine which has been designed for the high-speed issue of tickets under heavy traffic conditions.

GIRDLESTONE PUMPS, LTD.

A new range of industrial motorised centrifugal pumps, with totally enclosed electric motors, is shown for the first time by Girdlestone Pumps, Ltd., of Woodbridge, Suffolk. The units are being made in thirteen models, in sizes of ¾in and 1¼in, with screwed connections, and 1½in to 5in with flanged connections, all of which are suitable for heads up to 60ft. In addition, high-head pumps in 1in, 2in and 3in sizes will be available, for heads up to 150ft, according to the size of the pump.

An accompanying illustration, Fig. 24, shows the 1¼in pump, model 2 MT 150, with screwed connections, driven by a 1 h.p.

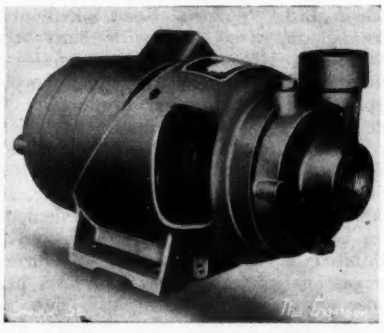


FIG. 24—MOTOR PUMP—GIRDLESTONE

motor. Normal speed of this particular model is 2850 r.p.m., and the delivery curve is remarkably flat for varying heads. For example, the delivery when the head is between 5ft and 25ft is 36 gallons per minute; at 30ft head, 35 gallons per minute; at 40ft, 33 gallons per minute, and at 50ft, 28 gallons per minute.

As already mentioned, each pump in the range has a totally enclosed driving motor of sufficient power to cover the whole delivery range of the pump. While it would be possible to fit motors of lower power for duty at the lower heads, the firm feels that such action would reduce the utility of the pumping set by preventing its transference to other duties. A substantial cast iron housing carries the motor at one end and the pump volute at the other, the impeller being mounted on a common pump and motor high-tensile steel shaft. Wide openings in the housing give access to the stuffing-box and a drip tray is incorporated in the base, with a tapped outlet. The impeller is double shrouded and carefully balanced. On certain models the impeller is of cast iron; on others it may be either of cast iron or gun-metal. According to the size and model, the driving motor is surface cooled or fan cooled, of squirrel-cage type, wound for 50 cycles, three-phase supply.

TOLEDO WOODHEAD SPRINGS, LTD.

The products exhibited by Toledo Woodhead Springs, Ltd., of Sheffield, include the grooved section laminated type of road vehicle spring illustrated in Fig. 25. It is claimed that the formation of a longitudinal groove in the compression side of the spring plates enables a saving of up to 10 per cent in the weight of material to be made.

The theory upon which the spring is designed is based upon the fact that when the tension side of a laminated spring plate is fully stressed the compression side is stressed somewhat less than is permissible.

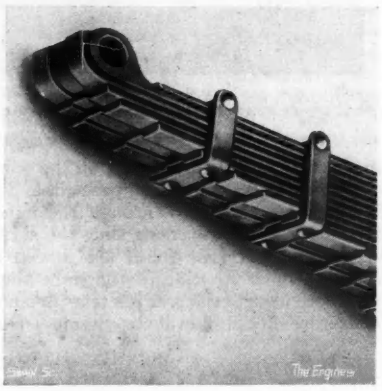


FIG. 25—GROOVED LAMINATED SPRINGS—TOLEDO

The introduction of a groove of suitable size on the compression side enables the stresses on both sides of the plate to reach the maximum desirable. It is also claimed that the presence of the groove by raising the neutral axis of the section favourably modifies the section modulus.

This firm is also exhibiting laminated and coil springs treated by the "Isopelting" process, in which they are shot blasted on the surface. The object of this process is to reduce tension stress in the springs for given loads and increase the working life.

THE QUASI-ARC COMPANY, LTD.

A representative selection of welding sets, electrodes and accessories is to be seen on the stand of the Quasi-Arc Company, Ltd., Bilston, Staffs.

One of the interesting new equipments is a motor generator set (MG 300) which incorporates an a.c. motor coupled to a Quasi-Arc drooping characteristic d.c. generator providing a welding current range of 20–300A. As illustrated in Fig. 26, the generator and motor are flange coupled to ensure maximum rigidity and accurate alignment. This method of construction gives a compact arrangement and simplifies the task of reassembly after overhaul. The set can be supplied as a stationary unit or mounted on three steel wheels, the front wheel being arranged to swivel with a hand drawbar as illustrated.

The main particulars of the set are tabulated below.

Dual control is incorporated, striking voltage and welding current being independently variable to allow the operator to choose any values suited to his particular requirements. Diverter control provides stepless regulation of the welding current,

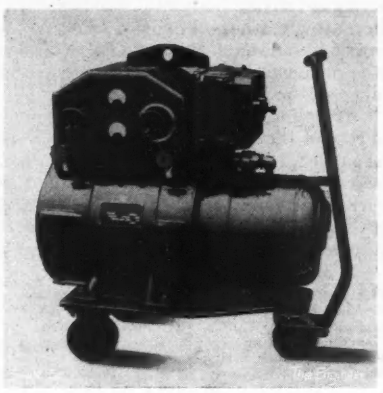


FIG. 26—MOTOR-GENERATOR WELDING SET—QUASI-ARC

while the new form of selector control gives fine control of the open circuit voltage. Physically the control gear is housed in a cabinet mounted on top of the generator frame; the handwheel on the left is the voltage control and the right-hand handwheel controls the current. The voltage

MG 300 Motor Generator Arc Welding Set

Welding current range	20A to 30A
Open circuit voltage range	50V to 70V
Speed	1450 r.p.m.
Motor rating at 400/440V, three phase, 50 cycles per second ...	15 b.h.p.
Overall dimensions without undergear	40in × 20in × 35in high
Net weight	10¾ cwt.

control is calibrated to show the class of work and the positions of welding. Operation of the dual control is simple: the operator turns the voltage handwheel pointer to the class of work on which he is engaged

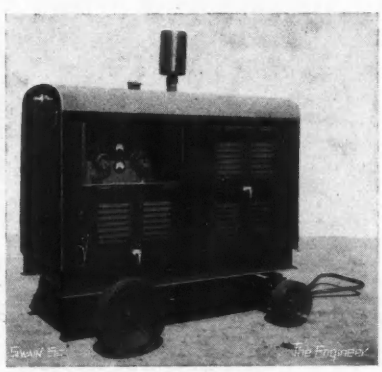


FIG. 27—DIESEL DRIVEN WELDING SET—QUASI-ARC

and then regulates the welding current in the normal way.

The motor is a three-phase squirrel-cage machine. It is complete with a star delta starter fitted with overload and low-voltage protection. Referring to Fig. 26, the starter is bolted to the right-hand end of the control cubicle.

Another exhibit is the DE 300 diesel

engine-driven portable welding set, based on the Quasi-Arc drooping characteristic d.c. generator coupled to a 2 V.S.H. two-cylinder Ruston engine, which is arranged for hand starting and is supplied complete with all accessories to form a self-contained power unit. The engine and generator are flange coupled like the units of the motor generator set described above, and the same form of dual control is embodied.

The DE 300 set is available as a stationary unit, or, as illustrated in Fig 27, the unit can be supplied on four steel wheels with swivelling front axle and hand drawbar. Alternatively, the equipment can take the form of a trailer unit mounted on two wheels with pneumatic tyres, tow bar, overrun brakes and parking jacks.

A 16-gallon fuel tank is mounted under the roof of the set and is fitted with a visual fuel gauge. It is stated that the consumption of diesel oil is approximately 1 gallon per hour, the average running cost being 9d. per hour. The leading particulars of the equipment are tabulated herewith :

DE 300 Diesel Engine Arc Welding Set

Welding current range	20A to 300A
Open circuit voltage range	50V to 70V
Speed	1500 r.p.m.
Normal engine rating	22·5 b.h.p.
Overall dimensions without undercarriage	70in × 30in × 56in high
Net weight	22 cwt.

As illustrated the set is completely enclosed in a robust steel housing fitted with louvred sliding doors fitted with quick-action locking handles. A lock-up compartment is provided for tools and accessories.

ALFRED HERBERT, LTD.

In addition to a representative range of hand and power-operated plastic moulding and die casting machines, Alfred Herbert, Ltd., of Coventry, is exhibiting a large number of small tools and precision measuring equipment.

The measuring equipment includes an improved model of the "Orcutt" individual base circle involute measuring and recording machine (Fig. 28) for checking gear tooth profiles. This machine is designed for gears from 16 to 2½ diametral pitch up to 24in outside diameter on an arbor in the spindle and without a centre support, and up to 15in diameter on centres with a centre support.

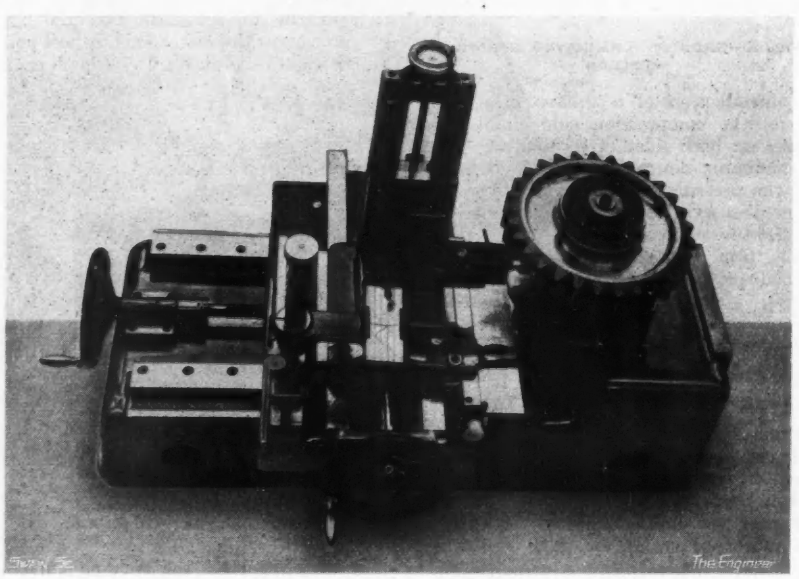


FIG. 28—BASE CIRCLE INVOLUTE MEASURING MACHINE—HERBERT

The machine operates on the principle of measuring the involute face of a gear tooth by generating a true involute form from a base circle engaging with a straight edge. The base circle discs are attached to the spindle on which the gear to be examined is mounted. The knife edge of the stylus of the indicating and recording unit is set to coincide with the straight edge, on the same slide, which engages with the base circle disc below the gear wheel. Through the hand-wheel of the cross traversing slide the stylus and the engaged gear tooth are moved in unison, the gear rotating at the same time. If the tooth form of the gear is a true involute, the recorder should show no lateral movement during the operation and its pen should trace a straight line on the chart.

In the new machine the work carrier or centre is rigidly mounted in precision bearings in the base of the machine and not on the traversing saddle, as hitherto. The recording instrument and the chart platform are mounted on the traversing saddle and the load distribution on the machine remains constant under all conditions of measurement. The mechanism actuating the saddle, which moves the recorder and the straight-edge into contact with a gear tooth and the base circle disc respectively, incorporates a pressure control device to prevent unnecessary pressure being exerted through the hand-wheel.

The machine is equipped to accommodate stem pinions as well as ordinary gears, and the bracket which supports the upper centre has a vertical screw for adjusting the centre bracket. The magnification between the stylus and the recorder is 350 to 1 and the vertical lines of the chart are calibrated in 0·0002in.

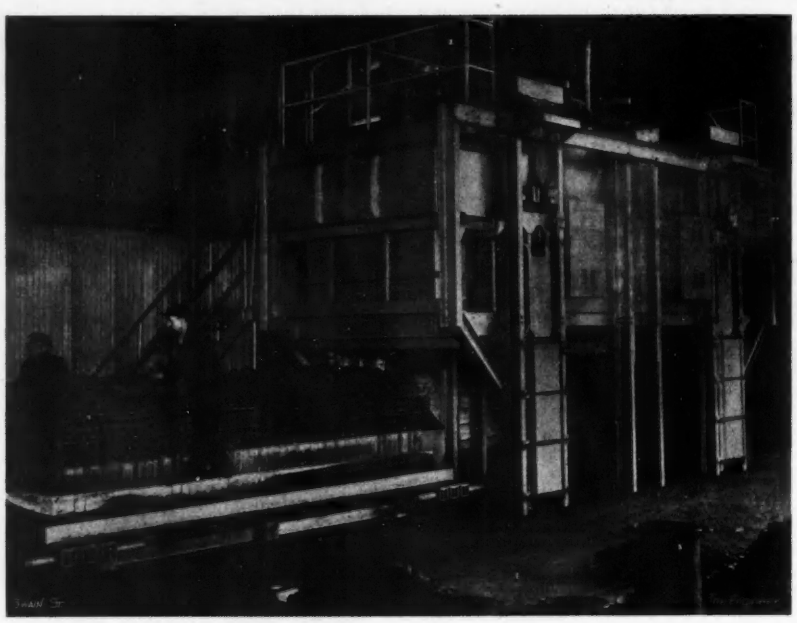


FIG. 29—ELEVATOR FURNACE FOR GASEOUS ANNEALING OF WHITEHEART CASTINGS—BIRLEC

BIRLEC, LTD.

Because of physical space restrictions, Birlec, Ltd., Tyburn Road, Erdington, Birmingham, in common with many other exhibitors, is obliged to confine its exhibits mainly to models and photographic displays illustrating its products. On this stand modern examples of furnace design for direct and indirect arc melting, induction heating and melting, pottery firing, gas carburising, copper brazing, and other specialised processes are depicted. One equipment which is too large to be exhibited is the Birlec elevator furnace for gaseous malleable annealing. Its principles and construction, however, are well demonstrated through the medium of a scale working model and photographs.

The Birlec gaseous annealing process for whiteheart malleable castings is designed to eliminate the conventional cans and iron ore and to reduce the annealing cycle to the order of forty-eight hours instead of five days or more, which is the period usually associated with the older process. With this reduction in time it is claimed that operating costs are substantially reduced.

Briefly, the equipment (Fig. 29) consists of an elevator furnace with its hearth in the form of a bogie, which is removable on rails at floor level. Two of these bogies are supplied with each furnace so that load-

ing, annealing and unloading can be carried out as a continuous operational cycle, as described more fully below. Gastight sealing is secured by a skirt on the furnace, which engages a sand seal on the hearth. Circulating fans are fitted in the roof of the furnace and the charge is loaded on the hearth so as to allow free circulation of the atmosphere over all parts of the charge.

The sequence of events in the annealing process can be considered to start with the first bogie ready charged and elevated to form the furnace hearth. The heater elements are switched on and the temperature control is set to the annealing temperature (1050 deg. Cent.). During the heating up stage the atmosphere initially in the furnace is air. In the early stages the oxygen from this air is absorbed by the castings with the formation of a thin film of oxide, nitrogen being left as the main constituent of the atmosphere. As the temperature rises this oxide film is reduced by the carbon in the castings and carbon monoxide and carbon dioxide are formed until, as the full temperature is approached, the atmosphere consists mainly of nitrogen and carbon monoxide. At this stage the circulating fans and decarburising fans are turned on, the air supply being adjusted to maintain the correct carbon dioxide content of about 6 to 7 per cent.

At the end of the soaking period the air supply is cut off, the furnace heating elements are switched off and the forced cooling system is started. When the temperature has fallen to about 550–600 deg. Cent. the bogie is lowered and transferred to the unloading station. In the meantime the second bogie is loaded ready to take the place of the first in the furnace and so the cycle is repeated.

The success of this process turns on the exact control of the atmosphere in relation to the progress of the annealing cycle. Air for decarburisation is admitted to the circulating system by means of a small blower with a control valve and flow meter. A carbon dioxide recorder is fitted and the atmosphere control is made fully automatic by means of electrical contacts on this recorder, operating a motorised valve on the air supply.

Automatic temperature control is incorporated in the furnace and safety devices are fitted to provide against any failure of the temperature control system. If desired, the whole cycle of heating, soaking and cooling can be made fully automatic.

GEORGE ANGUS AND CO., LTD.

Amongst the many products shown by George Angus and Co., Ltd., of Newcastle-upon-Tyne, technical interest perhaps centres

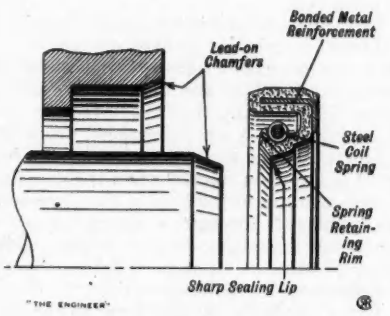


FIG. 30—OIL SEAL—ANGUS

on the display of oil seals, particularly the "Gaco" M.I. (metal insert) seal. The construction of the "Gaco" M.I. oil seal is illustrated in the cross-sectional view, Fig. 30, which shows a typical shaft and housing. The seal is composed mainly of "Gaco" material, a synthetic oil and heat-resisting rubber, within which is moulded a bonded metal reinforcement. A steel coil spring ensures contact between the sealing lip and the shaft.

The makers claim that "Gaco" material is particularly suitable for oil and grease seals, for speeds up to 60ft per second, and in some applications for temperatures up to 150 deg. Cent. By the metal insert form of construction advantages are said to be obtained in comparison with the metal-cased type of oil seal, as regards lightness and compactness and improved fluid-tight fit of the outer surface with the housing. Interferences in the case of the M.I. seals are normally greater than those of metal-cased oil seals of equivalent size, owing to the allowance for compression of the outer "Gaco" skin. Nominal interferences range from 0·006in to 0·014in, according to the size of the oil seal. A very wide range of sizes is made, for shafts varying from ¼in to 10in in diameter, or in metric sizes from 6mm to 60mm.

MOTOR RAIL, LTD.

A diesel-engined dumper of considerable interest is shown on the stand of Motor Rail, Ltd., of Bedford. It has a capacity of 3 cubic yards and is designed to carry a maximum load of 4 tons. As shown in the accompanying illustration, Fig. 31, the vehicle has a forward-control driving position. It is driven by a Dorman 20/28 b.h.p. twin-cylinder diesel engine.

Transmission of power is through a single-plate clutch and a double-range, three-speed and reverse gearbox, giving a total of six alternative forward speeds and two reverse speeds. The gearbox is close coupled to the driving axle, so that no propeller shaft nor universal joints are required. The driving axle is of the fully floating pattern, and runs on taper-roller bearings, with the drive taken through a spiral bevel crown wheel and pinion. The driving wheels are fitted with 13·00in by 24in tyres. Two independently operated (hand and foot) brakes apply separate shoes within 16in diameter brake drums on the driving wheels.

The front axle is centrally pivoted on a "Silentbloc" bearing, with radius rods to take thrust loads transmitted by wheel shock. On the front wheels tyres 31in by 9in are fitted.

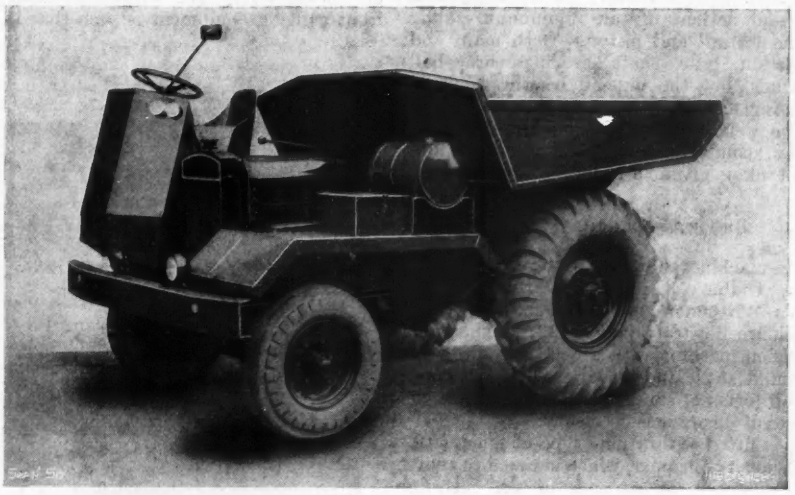


FIG. 31—3-CUBIC YARD DIESEL DUMPER—MOTOR RAIL

On release of a hand lever the skip automatically dumps the load by moving to a fully vertical position, beyond which it cannot go, because of the action of spring-loaded check chains. The loading or horizontal position is regained by reversing slightly, whereupon the skip returns to its lowered position.

THE VILLIERS ENGINEERING COMPANY, LTD.

Lightweight two-stroke petrol engines in a range of sizes made by the Villiers Engineering Company, Ltd., of Wolverhampton, are well known, and are on view on the company's stand. But more recent designs by Villiers have increased the range by adding a series of four-stroke units of 1 h.p., 1½ h.p. to

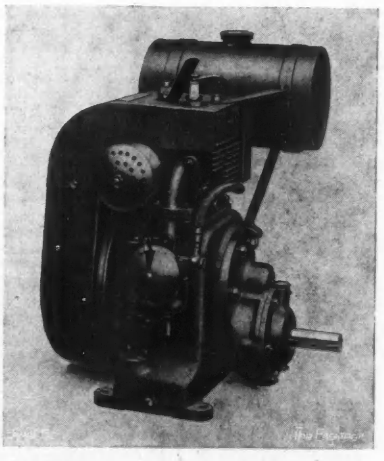


FIG. 32—3-H.P. ENGINE WITH REDUCTION GEAR—VILLIERS

2¼ h.p. and 2 h.p. to 3 h.p. ratings. All three new models are air cooled and all can be fitted with a vaporiser to run on paraffin as an alternative to petrol. The two larger models can be supplied with a 3 : 1 reduction gear, as illustrated in Fig. 32.

The engine illustrated is the biggest of the four-stroke range. It has a swept volume of 256 cubic centimetres, with a bore of 70mm and a stroke of 66·7mm. Its twelve-hour rating is 1·9 b.h.p. at 500 r.p.m. and 3 b.h.p. at 830 r.p.m. of the output shaft (1500 r.p.m. and 2500 r.p.m. engine speed, respectively).

As on other Villiers engines, ignition is

by a magneto built into the flywheel. The engine is a complete power plant, for there is a fuel tank of 1 gallon capacity mounted on one side, and lubricating oil is contained within the base casting. Totally enclosed and lubricated side valve gear is used, with a combination of an aluminium alloy cylinder head and piston. Both main and reduction gear shaft bearings are ball bearings, but the big-end bearing is fitted with replaceable white-metal liners.

The weight of the 3 h.p., Mk. 25 R.G., model, complete with reduction gear and fuel tank, is given as 75 lb.

BROOKES (OLDBURY), LTD.

The machines shown by Brookes (Oldbury), Ltd., Oldbury, Birmingham, include the firm's "Regent" model guillotine shears, which we illustrate in Fig. 33. This is a precision machine with a capacity of 8ft by ¼in mild steel, and is particularly designed for all forms of sheet shearing where a high degree of accuracy is necessary.

It is fitted with a new type of pneumatic hold-down or gripper, which is timed to come into operation in advance of the cutting.

The air cylinders which actuate the hold-down are of the single-acting type, and the return to the top position is effected mechanically by cams on the crankshaft. In operation, the cams first lower the hold-down into close proximity to the material and then air is admitted into the cylinders, which provide the actual gripping effort in addition to reducing the force of impact to a minimum.

A screw-operated back gauge on the machine can be set to close limits and incorporates a locking device to prevent "creeping" as a result of repeated impacts when sheets are being cut. Provision is made for operating the two screws simultaneously or independently, and the back gauge can be set at an angle if desired.

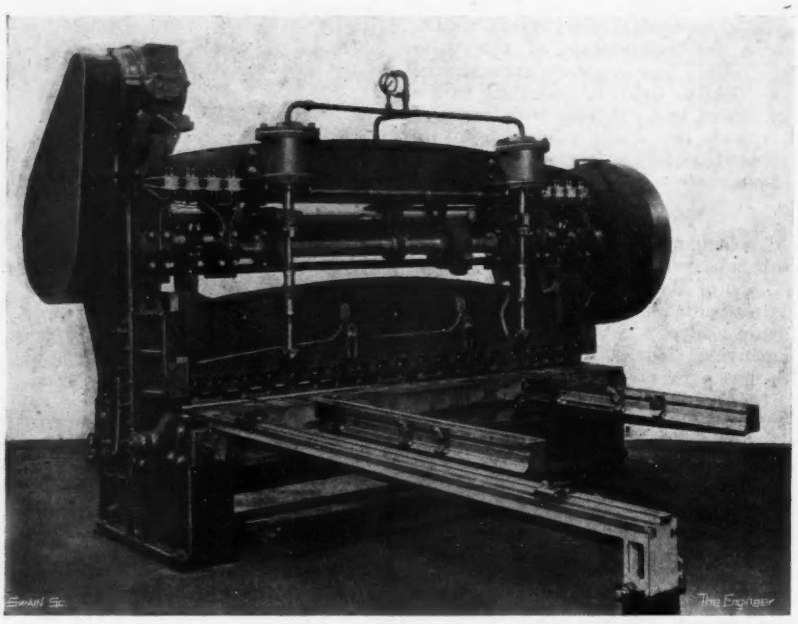


FIG. 33—GUILLOTINE SHEARING MACHINE—BROOKES

The front gauge equipment consists of extension arms, which can be adjusted to any position along the front of the machine. Each of these two arms is provided with an adjustable sliding stop working in conjunction with a built-in graduated rule of stainless steel. The rule has provision for adjustment so as to compensate for blade regrinding.

An 8ft squaring arm is fitted and provided with two adjustable stops of the swing-over type, which can be set to the built-in graduated rule. The arrangement of the front gauging equipment is such that it can be set to deal expeditiously with trimming and squaring sheets on all four sides.

The shears are operated by a pedal-controlled roller key clutch, which automatically stops the beam at the top of the stroke and gives only one stroke irrespective of whether the pedal is released or not.

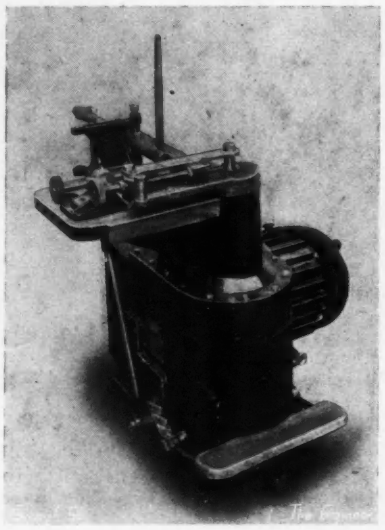


FIG. 34—TUBE BENDING MACHINE—BROOKES

A tube bending machine (Fig. 34) on the stand is the smallest in the range of three sizes of power tube benders made by the firm, and is designed for quantity production of small conduit bends, bicycle handlebars, &c. These machines are capable of bending tubes cold and unfilled.

The machines have built-in electrical equipment, comprising panel push-button control gear and totally enclosed fan-cooled flange-mounted two or three-speed change-pole motors. All the drive mechanism is enclosed and an oil pump ensures adequate lubrication to all moving parts.

The machine parts at the bending head are designed to give ample clearance to enable most types of tubes carrying earlier bends to clear when further bends are made. All bending mechanisms are arranged for reversing, so that right or left-hand bends can be obtained.

BLENDING MACHINE COMPANY, LTD.

Vibratory sifting machines of the wet type (Fig. 35) for slip and similar materials used in the ceramic industry are exhibited by the Blending Machine Company, Ltd., of Bond Street, Hockley, Birmingham. Three sizes of the machines are being shown, and they can be supplied with two, three or four screens or louvres with mesh sizes to suit the type of slip being handled.

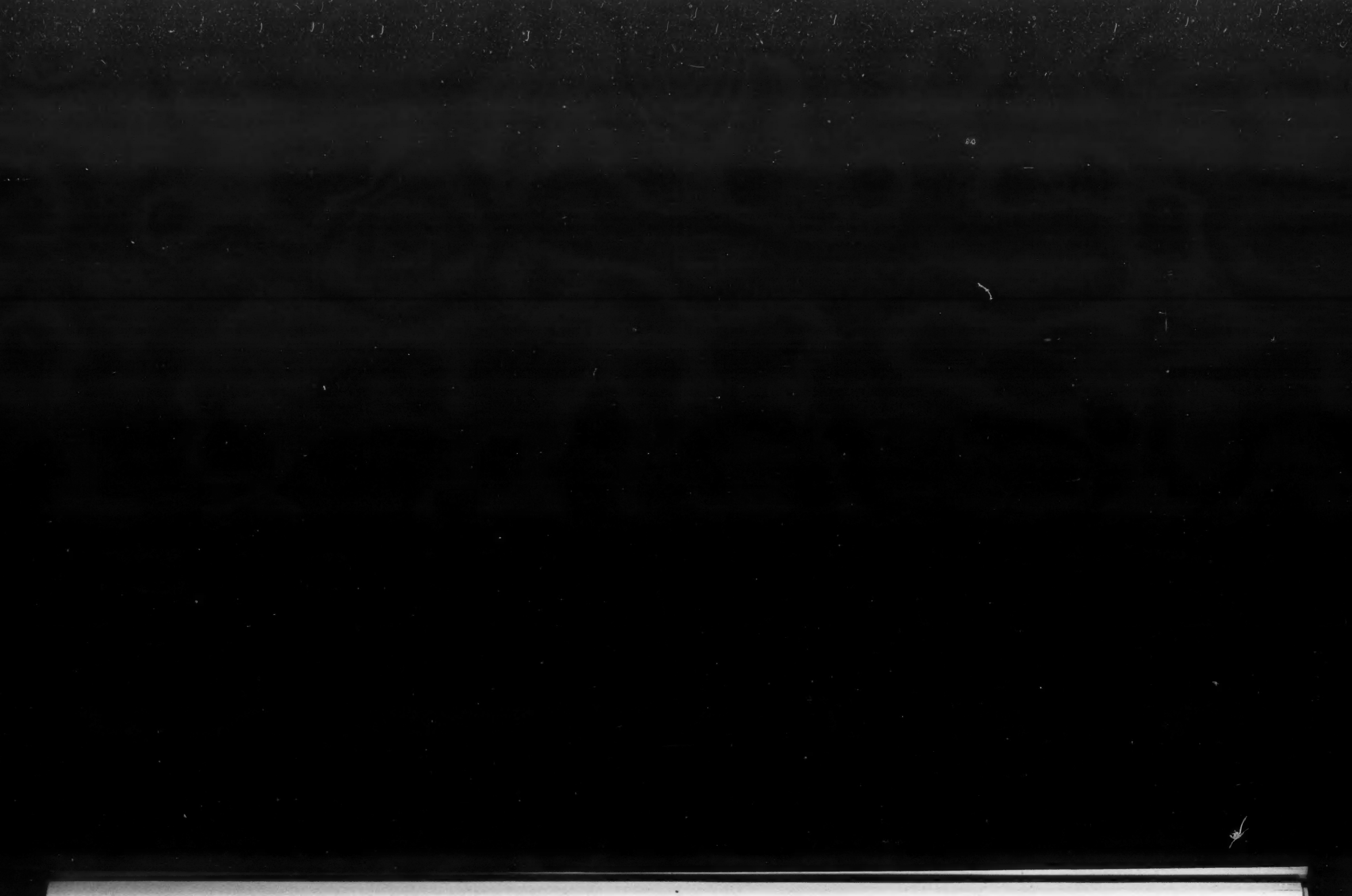
The screens of woven phosphor-bronze mesh are mounted in oak frames and are held rigidly together on the sieve frame body by cast aluminium clamping bars. The sieve body is suspended from four supporting arms on rubber links and is actuated by a high-frequency vibrating unit fastened to the underside. The front ends of the screens are open and the front suspension links can be adjusted to vary the angular setting of the louvres.

FIG. 35—WET SIFTING MACHINE—BLENDING

With the machine in operation material is fed continuously on to the top screen and that which passes through the series of screens drops into the dished base of the sieve body. Knottings removed in the screening process are discharged from the open ends of the screen into a receiving box fixed to the main framework of the machine.

Screened slip in the base of the sieve body is discharged through a nozzle on to a magnetic separating chute below, which removes any fine iron particles or slightly magnetic oxides in the material.

Other products of this firm to be seen include vibrating dry sifting machines, a two-roller tea cutting machine and a high-frequency vibrating foundry knockout for moulding boxes. This knockout is designed to handle boxes of up to 3ft by 2ft.



Boilers at Clyde's Mill Power Station*

By ERIC G. YARROW

IN February, 1942, the Clyde Valley Electrical Power Company ordered four water-tube boilers from Yarrow and Co., Ltd., Scotstoun, and in May, 1942, a further four similar boilers, for installation at Clyde's Mill Power Station, Glasgow. The drawings on the opposite page show the general arrangement of the two boilers, and test curves are reproduced herewith. Leading technical particulars are as follows :—

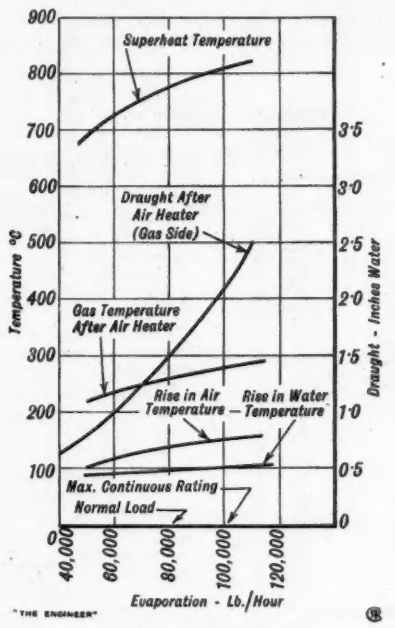
Number of boilers	Eight
Normal evaporation per boiler	80,000 lb per hour
M.C.R.	100,000 lb per hour
Pressure at superheater outlet	400 lb per sq in
Final steam temperature	785 deg. Fah.
Feed temperature entering economiser	250 deg. Fah.
Gas temperature at air heater outlet at normal load	275 deg. Fah.
Overall guaranteed thermal efficiency based on gross calorific value of fuel :	
Normal load	84·5 per cent
M.C.R.	83 per cent

The boiler units are housed in a separate building placed at right angles to the turbine room and are arranged in two rows, each of four units, with a central firing aisle. Each boiler is a self-contained unit with its own superheater, economiser, air heater and draught plant. The boilers are of the Yarrow " S.F.3 " type with generating tube heating surface 8980 square feet and water wall surface 366 square feet. Each boiler has one steam drum of 50in diameter and three water drums of 23in diameter. All the drums are seamless hollow forged steel with riveted ends. The tubes in the front and rear banks are 2in outside diameter and the centre bank 2¼in outside diameter. The majority of the tubes are straight and all are expanded directly into the drums. At each end of all the drums a manhole is provided to give access for inspection and cleaning of the tubes. Allowance is made for expansion and contraction by supporting the steam drum in cradles carried by the steel supporting structure. In this way the tubes and water drums are hung from the steam drum and are free to move up or down. The combustion chamber side walls are lined with Yarrow water walls consisting of bare tubes expanded into top and bottom headers and connected to the saturated steam drum by downcomer and upriser pipes. Each boiler has a Yarrow self-draining superheater with a heating surface of 3500 square feet. The superheater drum is of hollow forged seamless construction, 27in diameter, with riveted ends, and with 1¼in outside diameter U-shaped superheater tubes expanded into the superheater drum. A plate baffle is fixed below the steam drum to enable the final superheat temperature to be adjusted.

The economiser and air heater are arranged behind the boiler. Each boiler is fitted with a flash-welded mild steel tube type economiser of Babcock and Wilcox manufacture, with a heating surface of 4780 square feet and an air heater of the Yarrow tubular type with a heating surface of 15,000 square feet with tubes of 2¼in outside diameter, expanded into steel tube plates at the top and bottom. The gases flow upwards through the tubes and the air enters the top of the heater between the banks and makes a number of passes across the tubes. At low loads recirculation of air raises the temperature of the air entering the heater by 25 deg. Fah.

Each boiler has a style " 28 " Babcock and Wilcox travelling grate stoker, 18ft long by 16ft 6in wide. The grates are driven by electric motors through eight-speed gearboxes, giving a grate speed variation from 13ft to 65ft per hour.

The induced draught and forced draught fans are arranged above the boilers in a totally enclosed fan room, the gases from the induced draught fan being discharged into individual chimneys, one per boiler. Each boiler has a forced draught fan and induced draught fan of Howden make and a secondary air fan by Davidson. The forced draught fan has a capacity of 49,000 cubic feet per minute with a static pressure of 6·8in water gauge, while the induced draught fan has a capacity of 72,000 cubic feet per minute and a static pressure of 4·9in water gauge. Both the fans are driven by constant-speed squirrel-cage induction motors through hydraulic couplings with remote-speed control at firing floor level. The secondary air fan is housed in the basement beneath the economiser. This fan draws air from the main hot air duct and discharges through nozzles in the front and rear furnace walls and is driven by a constant-speed fan-cooled motor through a flexible coupling. The induced draught fan is fitted with a double-



TEST CURVES

scroll type Howden grit collector, which is placed on the suction side of the fan.

Each boiler, economiser and air heater has a complete set of Clyde soot blowers, which are arranged as follows :—

Boiler	Nine single-nozzle
Superheater	Three single-nozzle
Economiser	Three single-nozzle and three dual-nozzle
Air heater	Two dual-nozzle

The boiler and superheater soot blowers are controlled by automatic electrically operated gear.

Coal bunkers are mounted above the central aisle and are supplied with coal from the external coal-handling plant by means of duplicate gravity bucket conveyors. Ash and riddlings are discharged from hoppers in the basement into portable crushing machines, which in turn deliver to an ash suction plant.

The first four boilers were in operation in March, 1944, and the complete installation was handed over to the Clyde Valley Company in February, 1945.

Trial Results

Official trials were conducted on one of the boiler units, consisting of two tests, each of six hours' duration, at normal and maximum continuous rating respectively. The selected unit had steamed for fourteen months prior to the test, the only cleaning, other than regular shift operation of the soot blowers, that had been carried out during this period being rough cleaning of the centre bank of tubes. The soot blowers were used before and after, but not during the tests.

Results obtained during the two trials are given below :—

	Date of test March 27, 1945	Date of test March 28, 1945
Nominal evaporation, lb/hr.	80,000	100,000
Actual evaporation, lb/hr.	83,442	101,869
Pressure at superheater outlet, lb/sq in.	395	395
Final steam temperature at superheater outlet, deg. Fah.	784·3	794·5
Temperature of water entering economiser, deg. Fah.	247	245·5
Temperature of water leaving economiser, deg. Fah.	339	341
Temperature of gases leaving boiler, deg. Fah.	590	625
Temperature of gases leaving economiser, deg. Fah.	361	383
Temperature of gases leaving air heater, deg. Fah.	257	276
Temperature of air entering air heater, deg. Fah.	104	118
Temperature of air leaving air heater, deg. Fah.	240	259
Thickness of fire, in	4·75	5·75
Coal burned, lb/hr.	10,425	13,225
Evaporation per pound of coal, lb	8	7·7
Calorific value of coal as fired, B.Th.U./lb	10,684	10,581
Fixed carbon, per cent	43·60	43·78
Volatile matter, per cent	30·93	29·78
Ash, per cent	10·72	11·01
Moisture, per cent	14·75	15·43
Hydrogen, per cent	4·03	4·0
Ash produced, lb/hr.	954	1,323
Combustible in ash, per cent	6·6	6·73
Fine ashes produced, lb/hr.	28·8	25·0
Combustible in fine ashes, per cent	7·86	11·2
Riddlings produced, lb/hr.	7·9	9·4
Combustible in riddlings, per cent	16·97	12·91
Grit in last boiler pass, lb/hr.	16·6	52·6
Combustible in above grit, per cent	34	47·7
Grit in air heater, lb/hr.	12·5	0·875
Combustible in above grit, per cent	23·6	27·5
Grit in secondary collector, lb/hr.	37·6	33·1
Combustible in above grit, per cent	20·0	29·6
CO_2 at boiler outlet, per cent	14·52	15·13
CO_2 at air heater outlet, per cent	12·68	13·92
Combustion chamber suction, lb W.G.	0·042	0·031
Gas suction at boiler outlet, lb W.G.	0·8	1·0
Gas suction at economiser outlet, lb W.G.	1·22	1·6
Gas suction at air heater outlet, lb W.G.	1·63	2·1
Air pressure at F.D. fan discharge, lb W.G.	2·5	2·8
Air pressure under grate, lb W.G.	1·45	1·53
Secondary air pressure :		
Front, lb W.G.	5·83	7·7
Rear, lb W.G.	4·2	5·5
Power consumption of auxiliaries :		
I.D. fan, kW	39·50	53·35
F.D. fan, kW	28·73	34·18
S.A. fan, kW	24·97	26·85
Stoker, kW	1·13	1·42
B.Th.U. feed to final steam, per lb	1,190·8	1,197·8
B.Th.U. in economiser, per lb	94·5	97·6
B.Th.U. in boiler, per lb	894·6	892·7
B.Th.U. in superheater, per lb	201·7	207·5

Heat Balance

	B.Th.U.	P.c.	B.Th.U.	P.c.
Absorbed in boiler	9,531·2	89·21	9,226·6	87·20
Lost in dry products of combustion	300·2	2·81	344·9	3·26
Lost in excess air	129·3	1·21	105·8	1·00
Lost in moisture in coal	163·5	1·53	173·5	1·64
Lost in moisture from combustion	401·7	3·76	404·2	3·82
Lost in combustible in ash, riddlings and grit	115·4	1·08	141·8	1·34
Radiation and unaccounted losses	42·7	0·40	184·2	1·74
	10,684·0	100·00	10,581·0	100·00
Gross overall thermal efficiency, per cent		89·21		87·20
Heat absorbed by auxiliaries, calculated at 15,500 B.Th.U./kWh, per cent		1·31		1·28
Net overall thermal efficiency, per cent		87·90		85·92
Efficiency guaranteed, per cent		84·5		83·0

British Ceramic Society.—The spring meeting of the Refractory Materials Section of the British Ceramic Society is to be held in Newcastle-upon-Tyne on Wednesday and Thursday, May 12th and 13th.

* From a lecture delivered before the Scottish Engineering Students' Association at Glasgow and Edinburgh, December 11 and 12, 1947

Horizon Bar Approach Lighting System

A NEW type of airfield approach lighting, for use in foggy weather by day or by night, was recently demonstrated at the Royal Aircraft Establishment's airfield at Farnborough, Hants. "Horizon bar" approach lighting, as the system is called, has been fitted experimentally there, but is to be installed at London Airport for trials next winter. It is a great improvement on any system previously devised either in this country or the United States. It is intended for use in conjunction with blind approach radio aids, such as I.L.S. or G.C.A.

As the novelty of the system arises from the pattern formed by the lights, and has nothing to do with the design of the lighting fittings or control gear, to appreciate its full significance it is necessary to note briefly some of the considerations which led to its development.

Visual Judgments

It is universally agreed that instrument landing with radio aid is only a substitute for a visual landing. All pilots prefer direct vision in bringing aircraft down to the runway, and resort to blind approach methods only in case of necessity. Whatever refinements may be made in blind approach apparatus the pilot would sooner make the final approach by the aid of those judgments of height, distance and direction which he normally makes in clear weather.

In conditions of good visibility the pilot approaches a runway by taking a point just inside the threshold as an aiming point. His task is then to operate the controls so as to keep this point at a constant angle below the horizon, this angle being the glide angle. Visually, his altitude is given to him by the horizon and his alignment by the appearance of the edges of the runway. He judges his progress by the changing appearance of the runway, and his flattening out height both by the appearance of the runway and by the texture of the foreground. The final touch-down is probably judged mostly by texture. All this is true both by day and by night, because at night the edges of the runway are replaced by a double line of runway lights, and the only difference is that there is rather less texture to aid the final judgments. Approach lights are therefore not essential in clear weather.

Visual Aids

In bad visibility almost all these indications are blotted out, and part or all of the runway may not be visible at such a distance as to enable the pilot to act correctly. For a given meteorological visibility it is not possible to state exactly the distance at which the runway will be seen, for this distance varies according to the time of day, the reflectivity of the runway and its surroundings, and other factors; but, as a rough guide, it may be taken that in this country the runway is visible for about a mile when the meteorological visibility is 3 miles. A light of 5000 candles can be seen at a distance of a mile in such conditions.

It is therefore clear that when approaching the runway, in poor visibility conditions, high-intensity lighting can be seen and used by the pilot, providing the pattern of the lighting gives him the indications he requires. It is also clear that until the pilot can see such lighting his path must be given to him by other means, such as G.C.A., to guide him to the airfield approach. But it must be emphasised that a reasonably high limit to the final flying height at which radio aids are used must be observed, for radio aids guide the pilot in, but leave him blind if at the end of his approach he cannot see the runway and its approach lighting. Visual aids may therefore be regarded as one element of an integrated landing system, the other elements being radio approach aid and, in the worst conditions, F.I.D.O. Radio approach aid is relied upon to bring the aircraft down to within, say, 200ft of the ground, and to within 1000–1500 yards of the touch-down point. Thereafter, the lighting pattern is used. It is hoped that by using the right patterns for the visual aids, aircraft may land without F.I.D.O. down to meteorological visibilities of 200 yards in daylight, and perhaps to 100 yards at night. With the addition of F.I.D.O. it may be possible to operate at even lower visibilities.

It is on the above lines that work has been done at the Royal Aircraft Establishment in the development of lighting patterns. Mr. E. S. Calvert, head of the Illuminations Section, Electrical Engineering Department, was responsible for the studies, some of which he described in a paper read before the Royal Aeronautical Society on April 15th.

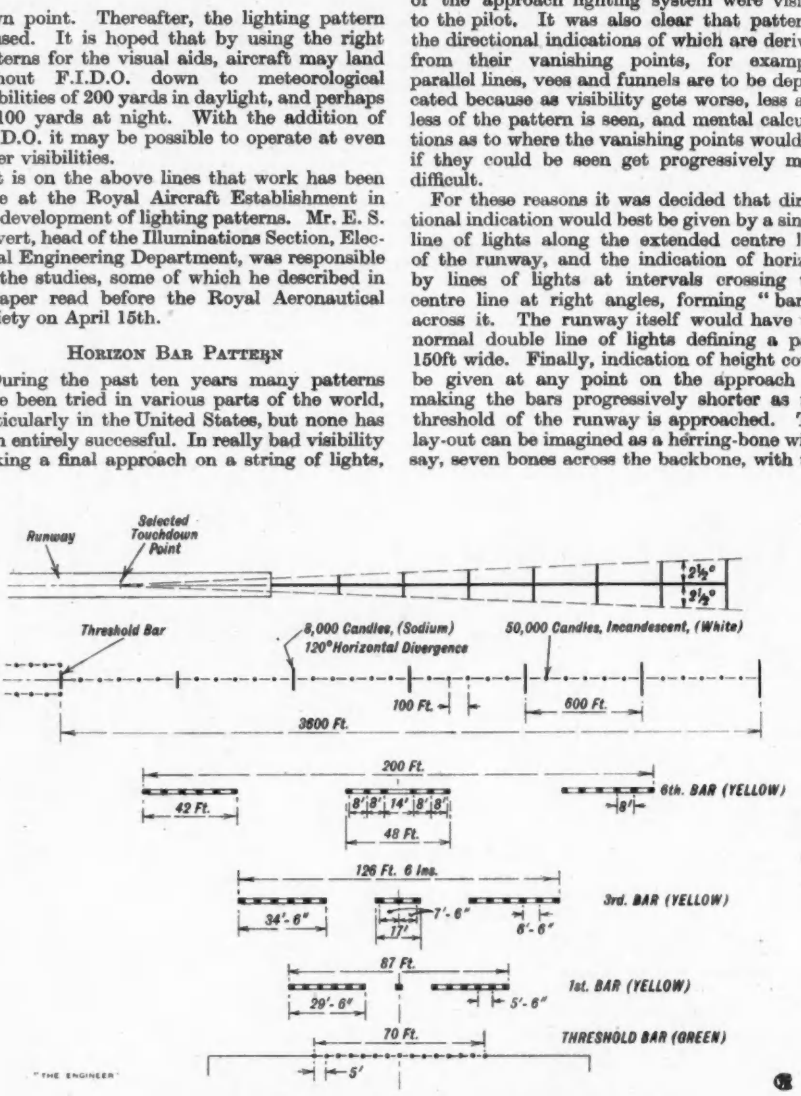
Horizon Bar Pattern

During the past ten years many patterns have been tried in various parts of the world, particularly in the United States, but none has been entirely successful. In really bad visibility making a final approach on a string of lights, or on a "vee" or funnel pattern, differs entirely from the normal clear weather technique using the visual judgments described above. As already mentioned, all the normal indications are absent: the runway lights are invisible for most of the approach, and the horizon is ill-defined or non-existent. Hitherto it has been widely supposed that if a pilot were able to see three or four lights ahead of him, he would somehow be able to complete his approach. Under test a few very experienced pilots have been able to do so, but the risk is great.

Even in better visibilities many pilots find difficulty in changing over from instrument flying to existing light patterns, and they complain that the lights play tricks. For instance, on first picking up the lights, the pilot, in correcting a lateral error, finds that the lights seem to slip sideways away from him, or even appear to swing from side to side, because it is difficult to distinguish between lateral displacement from the line of the runway, and the apparent movement caused by the aircraft banking. Also, since the normal light sources are small enough to appear as points, there is nothing except differences in intensity to indicate which lights are far off and which are near, and even that indication is faulty, because of the narrow divergence of the beams. Proper perspective is absent, because of the absence of an indication of the horizon.

It was therefore clear that the first requirement of a good lighting pattern was to supply the equivalent of a horizon, even if only a part of the approach lighting system were visible to the pilot. It was also clear that patterns, the directional indications of which are derived from their vanishing points, for example, parallel lines, vees and funnels are to be deprecated because as visibility gets worse, less and less of the pattern is seen, and mental calculations as to where the vanishing points would be if they could be seen get progressively more difficult.

For these reasons it was decided that directional indication would best be given by a single line of lights along the extended centre line of the runway, and the indication of horizon by lines of lights at intervals crossing the centre line at right angles, forming "bars" across it. The runway itself would have the normal double line of lights defining a path 150ft wide. Finally, indication of height could be given at any point on the approach by making the bars progressively shorter as the threshold of the runway is approached. The lay-out can be imagined as a herring-bone with, say, seven bones across the backbone, with the tail of the herring at the beginning of the runway, as shown in the accompanying diagram.



HORIZON BAR INSTALLATION AT FARNBOROUGH

To the pilot, if he is flying down the correct glide path, passing through the selected touch-down point, from wherever the pattern is picked up the cross bars appear always to be of the same length as they pass underneath the cockpit coaming, for then they subtend equal angles at his eye.

R.A.E. Horizon Bar Installation

The horizon bar installation at Farnborough was hurriedly made in a few weeks with the object of having it ready for fogs expected last February, but unfortunately the fogs occurred about a week too soon. To save time, only the high-intensity portion was installed, and dimming for operation in moderately clear weather at night was not provided. In a complete installation each high-intensity fitting would be duplicated by a low-intensity fitting, giving a beam all the way round in azimuth.

The actual arrangement and lengths of the bars are shown in the lower views of the accompanying drawing. The cross bars are spaced at 600ft centres, and the central line is 3600ft long. The lamps forming the centre line are spaced at 100ft intervals, and the lengths of the cross bars are such that they subtend an

angle of 5 deg. at the selected touch-down point (2½ deg. to each side of the centre line).

Demonstration flights by night and by day were given, and we confirmed that the bars, although of differing lengths, appeared always of the same length when passing out of the line of vision below the cockpit coaming. It was easy to understand the high degree of perspective and the certainty of the indications which would have been given to the pilot had the weather been thick.

Cyclorama

In the study of visual aids at Farnborough a difficulty found was that the pilot's reactions when flying in foggy weather could not be studied in clear weather, because the pilot always uses the clear weather technique if he is able to do so. Even when the desired atmospheric conditions do occur, the visibility may change markedly in a few minutes, and it is therefore impossible to compare two systems under identical conditions. It was therefore decided to attempt to simulate the behaviour of the world as seen by the pilot during the approach, reproducing various atmospheric conditions and errors as required. The apparatus used has now come to be known as the "cyclorama." The immediate reason for building the cyclorama was to demonstrate the behaviour of the horizon bar pattern described above. About 400 persons have used this device, involving about 8000 simulated landings, since its completion last October. Practically all pilots preferred the bar pattern to any of the other patterns projected on the screen of the cyclorama.

Briefly, the cyclorama comprises a pilot's cockpit, with the usual controls. The pilot views through an eyepiece screen, which tilts slightly as the joystick is moved up or down, simulating a change in attitude of the aircraft. On to the screen is projected a moving image of the pattern of the approach lights, the image travelling down the screen at a speed which can be set to correspond with any desired landing speed. Movement of the joystick to give bank or turn is reproduced on the screen by a rotation or corresponding movement of the image, exactly as would occur in flight. This motion is produced by suitable rotation of a prism between the projector and the screen. Further, the cross bars appear long or short, according to the height at which the approach is made, and the whole image may be slowly moved sideways, to simulate a cross wind. Between the projector and the screen is placed a revolving metal disc with openings in it through which the projected beam passes. The shape of the openings is such that by moving the disc up or down, the intensity of illumination of the screen can be graduated from top to bottom, to simulate foggy conditions, when the farther parts of the runway and approach pattern are invisible, the nearer parts becoming progressively more visible. Finally, there are automatic recorders, which plot the exact path of the aircraft during an approach run simulation.

This ingenious device was built by Mr. J. W. Sparke and Mr. H. F. Ringe, in about three months. It is very instructive to pilots and non-pilots alike, and is stated to have proved itself a useful research tool. By working the device, it is possible to state that it was relatively easy even for an inexperienced person to make a good approach run, after one or two trials to get used to the feel of the controls.

A Light Metal Coastal Craft.—The Admiralty states that the first light metal alloy coastal craft to be completed in this country, and possibly the first in the world, was launched from the yard of Saunders Engineering and Shipyard, Ltd., Beaumaris, on April 22nd. The craft, which is an experimental one, is to be known as M.T.B. "539." She is 75ft in length and has a beam of just under 20ft. The main feature of interest is the fact that her hull, including frames and skin, is made of an aluminium alloy, weighing about one-third the weight of steel. The hull will be somewhat lighter than an equivalent hull of wooden construction. Such a saving in weight can be used to make possible increased speed, increased range or increased armament and equipment.

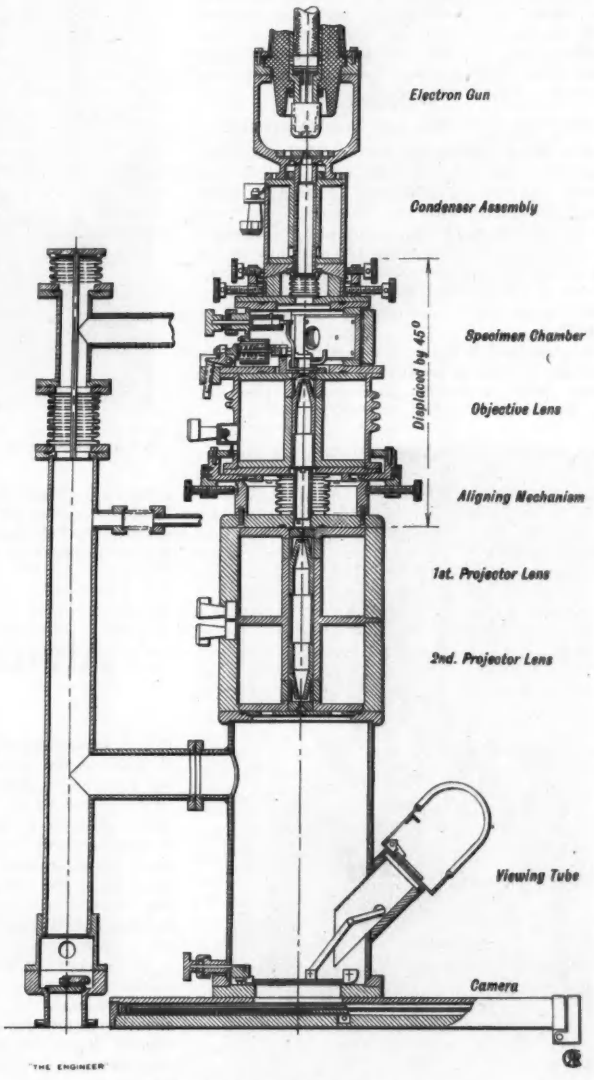
100-kV Electron Microscope

As a result of some three years' experience gained with the EM 2, 50-kV, electron microscope made by Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester, 17, the company has been able to incorporate a number of improvements in the new EM 3, 100-kV, electron microscope which was seen for the first time at the Physical Society's exhibition in London recently.

For the purpose of comparison, photographs of both equipments—the older type EM 2 and the newer prototype EM 3—are reproduced herewith. A sectioned drawing shows the general arrangement and some of the constructional details of the EM 3 microscope.

It will be seen that, in its present form, the microscope is mounted on a welded frame pedestal enclosed by sheet metal panelling, and arranged in the form of a desk. All the manual controls, including focussing and magnification, are grouped together on the left-hand horizontal panel in a convenient position for the operator, while the associated instruments are on a sloping panel at the rear of the desk. The right-hand top panel forms a convenient writing surface, and the desk contains the vacuum equipment (with the exception of the rotary pump) and the electronic control circuits for the microscope. A separate cubicle, remote from the microscope itself, houses the power supplies and the high-voltage, constant-potential unit which feeds the electron gun.

Many important technical improvements, each contributing something towards a reduction in the overall dimensions of the microscope, have made possible the marrying of the microscope proper and the control desk into a single compact unit.



100-kV Microscope in Section

The Microscope

In the first place, the electron gun has been redesigned completely so as to provide an electron beam of much higher intensity. Beam currents up to fifteen times those given by the old gun are obtainable from the new apparatus. In consequence direct electronic magnification up to 100,000 times can be achieved provided that the specimen under observation can withstand the intense electron bombardment.

Perhaps the most important change in design is the reduced size of the microscope tube resulting from the introduction of an extra intermediate projector lens. This additional lens also has the advantage of allowing the magnification to be varied over a wide range without altering the focal length of the objective lens.

Several benefits accrue from the reduction in size which makes the tube inherently more rigid. Because the volume of the tube is diminished the time for evacuation is now only two and a half minutes. Air locks can therefore be dispensed with, simplifying the design of the specimen chamber and the camera mechanism. Furthermore, the decrease in the overall height of the microscope allows the operator to reach all of the alignment controls without leaving his chair. The magnetic lens has been redesigned to accommodate the windings outside the vacuum system—a form of construction which simplifies evacuation, improves cooling and permits more ampere turns to be used in the available space.

Provision is made for a physical aperture to be fitted to the objective lens, strongly enhancing the contrast of the image; this effect is particularly noticeable when examining specimens with high scattering powers. Dark field illumination images can also be formed with the aid of this objective aperture, by tilting the electron beam with respect to the axis of the microscope so that the beam is cut off by the edge of the aperture. The image is then formed by the electrons diffracted at the specimen into the aperture of the objective lens.

Without sacrificing the ease of control inherent in the earlier instrument, the specimen holder in the later version has greater mechanical stability. A stereoscopic device

has been incorporated so that the specimen can be tilted while it is actually under observation on the microscope screen. The direction of tilt is along the line of one of the push rods controlling the specimen stage position. This property, together with the flexibility of the twin projector lens system, allows the correct orientation of the image to be obtained on the final screen.

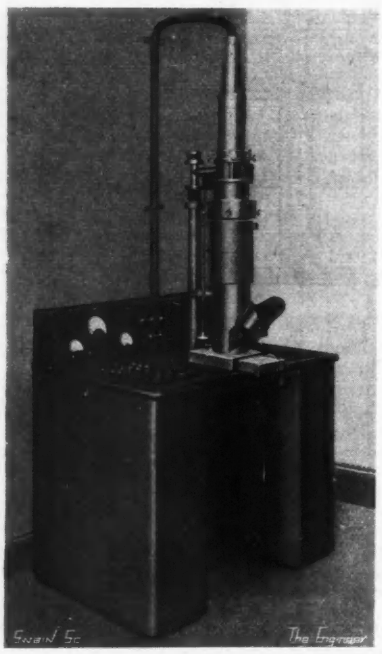
No intermediate viewing screen is included in this instrument, since by using the lower projector lens at low magnification an effective intermediate image is formed on the final screen of the microscope. The viewing chamber of the microscope is provided with a single port of sufficient width for two or three observers to view the screen simultaneously.

Some space has been saved in the design of the camera for the new microscope. Two 3¼in plates can be accommodated side by side and on each plate pictures of various sizes can be taken by masking—either one picture 3¼in square, two pictures 1¼in by 3in, or four pictures ¾in by 2in—the selection of frame size being accomplished by a single masking control.

Control Circuits and Power Supply

Electronic control circuits provide a stabilised variable current source for each of the four lenses in the microscope. Although these circuits are basically the same as those used on the EM 2 microscope, a number of changes have been made to improve the stability of the lens current. Since the new objective lens works at a fixed focal length, greatly increased stability at any value of lens current can be achieved.

Segregation of the power supply in a remote cubicle is done primarily to avoid setting up stray fields near the microscope. The h.t.



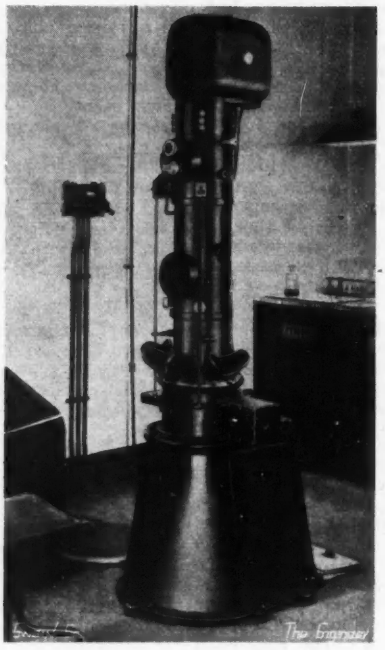
100-KV Electron Microscope, Type EM3

oil-immersed, constant-potential unit is fed from a high-frequency source which results in a substantial saving in weight and bulk, the h.t. generator being contained in an oil tank of approximately 1ft cube. A selector switch allows the high voltage to be adjusted to three different values.

The h.t. generator output is stabilised to 1/50,000 by a feed-back amplifier, which controls the amplitude of the oscillator feeding the rectifier. Integral with the h.t. generator is an l.t. stabilised source of high-frequency current for supplying the filament of the electron gun. A screened cable connected directly to the electron gun carries the h.t. and filament supplies from the generator cubicle, making the insulation independent of atmospheric conditions.

Vacuum System

A simplified form of manually operated high-vacuum plant is incorporated in the EM 3 microscope. In conjunction with a standard



50-KV Electron Microscope, Type EM 2

rotary pump there is an oil diffusion pump which is connected to the exhaust manifold of the microscope through a high-vacuum valve. By including this valve on the high-vacuum side the microscope column can be opened to the atmosphere without switching off and cooling the diffusion pumps. Without this valve air locks for the camera and specimen chamber would be necessary. To minimise the transmission of vibration to the microscope tube the rotary pump is mounted separately on "metalastik" supports.

A pair of vacuum valves between the rotary and diffusion pumps serve to connect the microscope direct to the rotary pumps for obtaining a rough vacuum before the valve on the top of the oil pump is opened. When evacuating the tube both the rotary pump and the oil diffusion pump can be switched on simultaneously since the rotary pump evacuates the microscope to 10^{-2}mm hg. in about two minutes, while the diffusion pump requires about fifteen minutes to reach the operating temperature. A lamp indicates when this temperature is reached, and, at the same time, interlocks are released so that the h.t. and filament supplies can be switched on.

Performance

The magnification of the EM 3 microscope can be varied from 1000 times up to 100,000 times without changing the holder. At the higher magnifications the illumination is sufficiently intense for visual work, while the specimen stage is stable enough mechanically for micrographs to be taken. The low magnification is obtained, relatively free from distortion, by virtue of the double projector lens system. Provision is made for obtaining stereoscopic pairs of micrographs without removing the specimen from the microscope.

Although the electron optical design of the magnetic lenses is substantially the same as it was in the older instrument, advances have been made in the accuracy of manufacture with a corresponding increase in the resolving power of the instrument.

The possibility of increasing the voltage of the high-frequency h.t. generator is under investigation, and, since the microscope has been designed for a magnification of 50,000 at 100kV, it is hoped in the near future to supply units to give this voltage.

Aluminium-Sheathed Power Cables

No. II—(*Continued from page 399, April 23rd*)

THE use of an aluminium sheath instead of lead causes no appreciable modification to the heat conduction and dissipation constants of a power cable. For any given value of heat generated the temperature gradients throughout the insulation, sheath and servings show no significant change. It follows, therefore, that, for equal conductor temperatures, the current ratings of cables are unchanged by the substitution of aluminium for lead as the sheathing material.

An exception to this general equivalence occurs with single-core cables carrying alternating currents; in this instance, the reduced sheath resistance and the increased eddy current sheath losses necessitate some derating of the aluminium-sheathed cable when direct bonding is used.

On the other hand, the ability of aluminium sheaths to withstand much higher internal pressures than lead modifies an important limitation on the current rating—the transient pressures set up by rapid compound expansion on load—and the possibility of operating at conductor temperatures of 80 deg. to 85 deg. Cent. can be envisaged. This possibility suggests the prospect of a reduction in copper cross section in any instance where this area is determined by current density rather than by voltage drop.

Corrosion

Under normal atmospheric conditions the resistance to corrosion of aluminium is well known from practical experience in various applications, such as overhead transmission lines. In the presence of oxygen a freshly exposed surface of aluminium rapidly acquires an oxide film which forms a natural protective coating. Aluminium oxide is highly resistant to many chemicals, but is attacked by certain alkalis, particularly chlorides of fairly high concentrations. Consequently, aluminium-sheathed cables can, if required, be installed (above ground) unprotected, without fear of chemical attack except, perhaps, in heavily salt-laden atmospheres.

Practical experience is less extensive where unprotected cable is laid direct in the ground or drawn into ducts. Although it is likely that many common soil conditions would not be inimical, others, strongly alkaline and capable of penetrating the oxide film, would be strongly corrosive.

Galvanic action presents another hazard which must be avoided. Direct contact with other metals such as brass or copper must therefore be avoided where moisture is likely to be present, since, in view of its position in the electrochemical series, aluminium is particularly susceptible to attack by galvanic action.

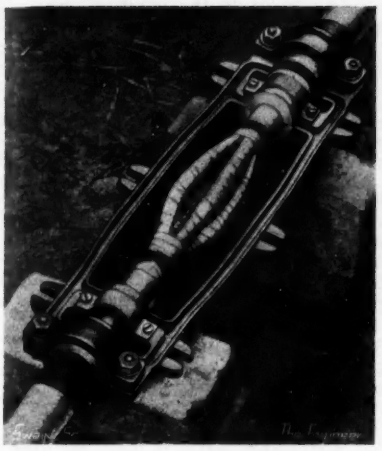
Accordingly, the aluminium sheath, like the lead sheath, must be served with a protective covering. Extensive investigations by Johnson and Phillips, Ltd., over a period of twelve months have shown that the standard protective coverings normally applied to lead sheaths prove equally effective in preserving aluminium-sheathed cables from corrosive deterioration.

As with lead-covered cables, two distinct kinds of covering are normally supplied for the aluminium sheath—one for ordinary underground service, and the other for conditions

of extreme severity. The standard coating consists of two successive layers of bitumen-compounded paper tapes followed by textile tapes, with coatings of waterproof bitumen applied between layers and overall. The special protection comprises wrappings of rubber compound tapes, followed by textile tapes, with intermediate and overall layers of waterproof compound.

Installation, Jointing and Terminating

The installation of J. and P. aluminium-sheathed cables as compared with lead-covered cables is distinguished by two main factors—reduced weight and increased tensile strength. A third consideration, the increased stiffness,



Compound Sealed Joint

is of secondary practical importance, since, according to the makers, no great difficulty is experienced in bending the cable to conform with the runs normally encountered. One of the illustrations reproduced on page 398 of last week's issue illustrates the kind of bend that can be achieved by normal installation methods.

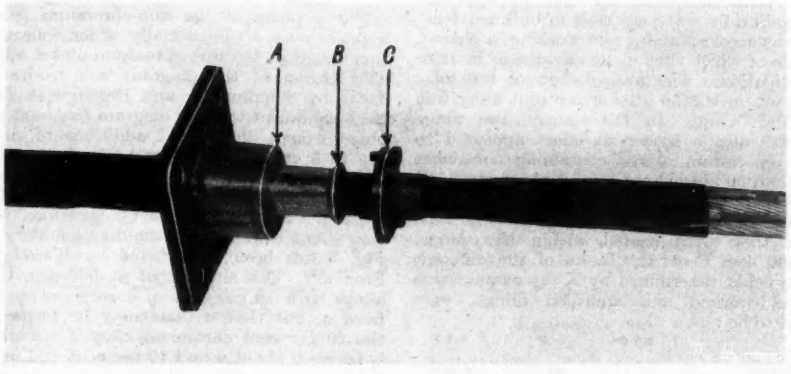
For surface installations, aluminium-sheathed cables require fewer fittings than are needed for lead-covered cables, because of the difference in weight. In underground installations the new cable can be laid direct or in ducts, and it is claimed that, even in the absence of armouring, failure due to minor ground subsidence or traffic vibration need not be feared. On the other hand, where there is obvious risk of mechanical damage armouring must, of course, be used.

Probably the main divergence between aluminium and lead sheathing is to be found in jointing techniques, although in the many instances where compound sealing is satisfactory even these differences disappear. Considering this category first, compound sealing can be used in fittings of orthodox design whenever the conditions are such that the joints and terminations do not require plumbing. Accordingly, when the conditions are suitable the cables are entered into the orthodox cast iron or aluminium boxes through compound sealed glands, provided that precautions are taken (for example, by including aluminium bushes) to prevent contact between the aluminium sheath and other metals. An underground compound filled joint of this kind showing a straight-through connection between an aluminium-sheathed cable and a standard lead-covered cable is shown in one of the accompanying illustrations.

In situations where hermetic sealing of the joint is considered necessary a departure must be made from the established technique developed for lead-covered cables, since the making of soldered or sweated unions with aluminium presents considerable difficulty. Although substantial progress has been made towards solving this problem, so that a satisfactory soldering technique has been developed under controlled workshop conditions, this method is not suitable for use in the field.

Accordingly, for totally sealed joints and terminations a simple and robust design of mechanical union has been developed to replace the normal plumbing gland. This union, which can be adapted readily to existing joint boxes and sealing ends, consists of two main elements as illustrated herewith. A conical seating is formed in one face of the ring A to receive the corresponding conical portion of the ring C. The end of the sheath is suitably belled as at B, so as to be gripped between the rings A and C when the clamping screws are tightened. Sufficient area of contact is provided between the clamping rings and the belled end of the sheath to ensure that the assembled union will serve the same purpose as the plumb it replaces. In this union the only contact between the aluminium sheath and any other metal is at the clamping steel rings, the seating faces of which are cadmium coated to exclude any risk of galvanic action.

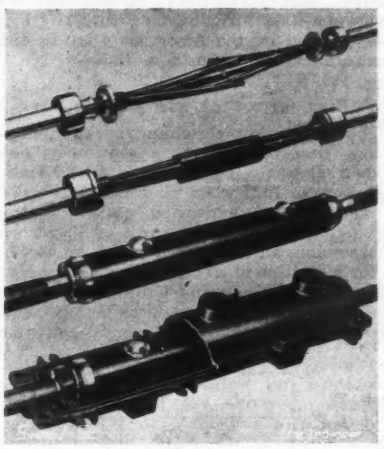
The construction of a typical straight-through joint embodying this design of union is shown stage by stage in an accompanying illustration. Two unions are applied as end fittings and a sleeve of lead or tinned copper is slipped over the joint and plumbed to the two unions in the usual way. Thus the sleeve completely encloses the mechanical fittings and, in accordance with standard practice, the completed joint is housed in a concrete or metal box filled with a suitable bitumen compound to protect the sleeve fitting and cable ends from moisture.



Mechanical Union

When armoured cable is used in conjunction with a cast iron outer box the armour is secured in a clamp in the normal way. With unarmoured cable a substantial bonding clamp, which is bolted direct to the box illustrated, is capable of withstanding considerable compressive or tensile forces and relieving the sleeve of the corresponding loads. Nevertheless, the mechanical strength of the union alone is probably more than adequate for the purpose, the minimum "pull-out" load for a 1½in diameter sheath being of the order of 2200 lb.

Bonding and earth connections present no difficulty provided that certain simple requirements are fulfilled to combat the oxide film which forms on the aluminium surface in the presence of oxygen. This oxide film has insulating properties which hamper the making of earth connections or bonding across joints—the more so since these connections will not normally be soldered. Experience gained with the making of "contact" connections with aluminium busbars, &c., suggests that the difficulty is readily overcome. When using a mechanical grip to form a connection with an aluminium sheath the makers recommend that the contact surface should be smeared with petroleum jelly, and then



Hermetically Sealed Joint

burnished with fine emery paper prior to applying the connector and pulling tight.

Sealing of cable ends for despatch and storage involves a soldering process which has been specially developed for wiping the aluminium sheath to a lead cap which is fitted over the cable end. Using a special bonding material, a suitable flux, correct preparation and temperature, the makers are able to ensure a satisfactory wiped joint. The higher temperature and longer heating period may char or damage the insulation on the last foot or so of the cable, but this is no serious drawback to the technique as applied to the cable end, as distinct from a joint.

We are informed that joints and terminations of the kind described above have been thoroughly tested, and that prototypes have shown themselves to be capable of sustaining, indefinitely, pressures of 400 lb per square inch without any trace of leakage.

Canadian Asphalt Plant

The Standard Oil Company of British Columbia, Ltd., Vancouver, has commenced the construction of a new asphalt plant, representing an investment of nearly 500,000 dollars. The area occupied by the company's Stanoven refinery on the south shore of Burrard Inlet in Burnaby was chosen as the site. The new plant will provide facilities for the manufacture, blending and shipping of asphalt and cut-back asphalts. The plant will provide for the manufacture of a wide range of asphalts under vacuum and at low temperatures. While the extraction of asphalt products will result in a lowering of the percentage of fuel oil available for sale, the actual quantity of this very necessary product will not be reduced, because the additional facilities will not only provide for the manufacture of asphalts but will also substantially increase the total refinery capacity. Included in the construction project are new tank truck and tank car loading facilities, an additional boiler, and the erection of thirteen additional storage tanks. When completed, the asphalt plant will have a daily capacity of about 175 tons of finished products, including all grades of paving asphalts and cutback asphalts.

Metallurgical Topics

The Sigma Phase in Alloys Containing Iron and Chromium

In view of the publication by the Iron and Steel Institute of two papers on the sigma phase in molybdenum-bearing chromium-nickel steels (one by Messrs. H. W. Kirkby and J. I. Morley, and the other by Messrs. L. Smith and K. W. J. Bowen), a brief account of the discovery of the sigma phase and a review of the present state of knowledge of its occurrence in alloys containing iron and chromium may be of interest. Mention should be made of an earlier review, entitled "The Sigma Phase," by F. B. Foley, issued by the American Alloy Castings Institute as *Alloy Castings Bulletin*, No. 5, July, 1945.

Recognition of the New Phase

The binary iron-chromium alloys were for a long time regarded as a continuous series of solid solutions. Doubts about this conclusion first arose in 1927 when Chevenard[1] recognised in the thermal expansion curves of iron-chromium alloys with upwards of 40 per cent of chromium an irregularity which he ascribed to the formation of a compound; and at about the same time Bain and Griffiths[2] discovered, in alloys containing approximately equal amounts of chromium and iron, a constituent

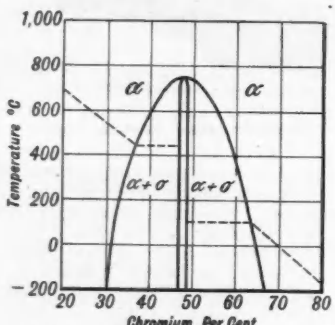


Fig. 1—*Iron-Chromium Diagram Proposed by Kinzel and Crafts on all Data Available in 1937*

which occurred only at temperatures below about 900 deg. Cent. and which was distinguished by its non-magnetic character, hardness, brittleness and complexity of X-ray structure. The X-ray indications were not confirmed by Westgren, Phragmén and Nigresco,[3] whose results supported the original conception of a continuous series of solid solutions; but Wever and Jellinghaus[4] in 1931 obtained definite indications, in alloys containing approximately 40 to 60 per cent of chromium, of a phase to which they assigned the formula FeCr and which was precipitated by annealing at 600 deg. Cent. for four days and was redissolved by annealing at 1200 deg. Cent. In the same year, Adcock[5] reported that alloys containing 48·8 to 50·5 atomic per cent of chromium, vacuum-annealed at 1300 deg. to 1350 deg. Cent. to remove coring, then at 600 deg. for four days, showed no indication by hardness, brittleness or microstructure of the presence of an intermetallic compound, and filings which were made from these samples and again annealed at 600 deg. for thirty minutes showed no change in X-ray pattern or in lattice constant. A change was, however, produced by annealing in nitrogen, and it was concluded that this might have been responsible for the results obtained by Wever and Jellinghaus, whose alloys were not so pure as those of Adcock and contained appreciable amounts not only of aluminium, which would tend to aid nitrogen absorption, but also of silicon, which, as was realised later, would render the annealing at 600 deg. more effective. It is true that Adcock found that the annealing treatment at 600 deg. Cent. raised the temperature of the magnetic transformation, but, on the whole, the balance of evidence available in 1931 was that the pure, uniform iron-chromium alloys formed an unbroken series of body-centred cubic solid solutions at room temperature. In the course of a few years, however, the intermediate phase corresponding to the formula FeCr was again recognised in the iron-chromium alloys by Eriksson[6]; and, in 1936, Anderson and Jette[7], by X-ray investigation of the iron-chromium-silicon alloys, found a compound having a similar diffraction pattern to that assigned by Wever and Jellinghaus to FeCr. Although they were concerned with the ternary system they found that the compound persisted in iron-chromium alloys containing as little as 0·087 per cent of silicon. Subsequently, alloys containing about 50 per cent of chromium were prepared by Jette and Foote[8] from carbonyl iron and pure electrolytic chromium by vacuum melting; they were annealed for a week in hydrogen at 1000 deg. Cent. and then in evacuated quartz tubes at 700 deg. Cent. for five days. By this treatment the alloys were converted almost completely into the new phase which the authors called sigma (Σ) printed as a capital. In an alloy with 50·6 atomic per cent of iron the transformation temperature was found to be between 775 deg. and 800 deg. Cent. and the transformation was strictly reversible. The inversion took place very slowly, but was accelerated by the presence of silicon and also by cold work. At the same time, it was found that Adcock's procedure, viz., heating the pure well-annealed alloy for four days at 600 deg. Cent., produced little or no precipitation of sigma. The rate of change is so slow that no detectable amount of the sigma phase can be formed during ordinary rates of cooling. Below 800 deg. Cent. sigma is precipitated if sufficient time is allowed, and the time required increases considerably as the temperature falls. Location of the boundaries of the sigma and the sigma+alpha regions is therefore difficult.

Sigma in the Fe-Cr Alloys

A provisional diagram, incorporating all the data available at the time, was proposed by Kinzel and Crafts[9] in 1937, and is shown in Fig. 1. More recent work by Cook and Jones[10] at the National Physical Laboratory has gone far to establish the limits within which the σ phase exists in the pure iron-chromium alloys. They confirmed that the rate of approach to equilibrium was very slow in bulk material, but was accelerated by cold working, a characteristic of which they took advantage in their investigation. The temperature of the $\alpha \rightarrow \sigma$ inversion in the 50 atomic per cent alloy was 820 deg. Cent. In the temperature range 770–820 deg. a hysteresis effect appeared to exist in certain alloys containing somewhat less than 50 atomic per cent of chromium, and the initial structure of these alloys persisted without change for very long periods of time when they were heated within this range. At 600 deg. Cent. the limits of the different phase fields, determined by X-ray examination of cold-worked and annealed filings, were found to be:

	α+σ	σ	α+σ
Atomic per cent chromium ...	26–44	44–50	50–71
Per cent by weight	24·7–42·3	42·3–48·2	48·2–69·5

Cook and Jones's diagram is given in Fig. 2.

Sigma in the Fe-Cr-C Alloys

The most complete study of this system was made by Tofaute, Küttner and Büttinghaus[11] (1936). Precipitation of compound FeCr (σ phase) was reported to occur in alloys with 40 to 60 per cent of chromium along with the carbide $(Cr,Fe)_4C$, and led to such great brittleness that some of the alloys could be pounded to a fine powder. In the 60 per cent chromium alloy (Fig. 52 in "Alloys of Iron and Chromium" by Kinzel and Crafts[9]), the phase field, $\sigma + (Cr,Fe)_4C$, is similar in form to the iron-chromium σ region, and is bordered on each side by regions of α+σ+carbide. The maximum temperature of the inversion was a little over 900 deg. Cent. and the carbon content corresponding to this maximum varied with the chromium content. With 50 per cent of chromium it occurred at 0·5 per cent carbon, and the carbon content beyond which no σ was found was just under 3 per cent. At about 47 per cent chromium only the lines to the right of the peak remain in the diagram. With lower chromium the temperature at which σ separates is progressively lowered and the carbon content beyond which it ceases to exist is reduced to nil at 30 per cent chromium. With 30 to 45 per cent chromium the effect of increasing carbon content is to reduce the temperature at which σ may separate.

Sigma in the Fe-Cr-Si Alloys

As already mentioned, the iron-chromium-silicon system was investigated in 1936 by Anderson and Jette, who found that the intermediate phase, identical with that recognised by Wever and Jellinghaus in the iron-chromium alloys continued to exist at higher temperatures, and also separated in alloys with lower chromium content, in the presence of silicon. For example, in the alloys containing 20 per cent of chromium σ was precipitated from the α at 1000 deg. Cent. when the silicon exceeded

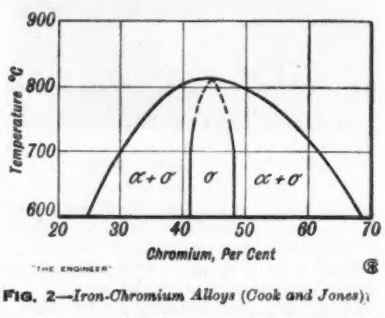


Fig. 2—*Iron-Chromium Alloys (Cook and Jones)*

7 per cent; at 600 deg. when it exceeded 4 per cent. Even with only 15 per cent of chromium, alloys containing between 6 and 12 per cent of silicon fell within the α+σ region at 600 deg. Cent. Thus, in the presence of silicon, σ may extend over a much wider field than in the binary iron-chromium alloys.

Sigma in the Fe-Cr-Ni Alloys

The σ phase of the iron-chromium system appears over a substantially wider concentration range in the iron-chromium-nickel alloys. This region of the diagram was studied in detail by Schafmeister and Ergang[12] in 1938. No amendment to their diagram has been proposed except that small additions of nickel (up to 3 or 4 per cent) probably increase the width of the σ region instead of decreasing it continuously as shown by Schafmeister and Ergang. From their results, therefore, with very slight modification, the diagram shown in Fig. 3 has been constructed by Kinzel and Franks.[13] This shows that at 650 deg. Cent. alloys with 18 per cent of chromium are free from σ, but that a little may be formed in the 20 per cent chromium alloy if the nickel is between about 4 and 10 per cent and in the 25 per cent chromium alloy with nickel between about 1 and 15 per cent. In alloys with much more than this amount of chromium the presence of nickel is not necessary for the formation of σ, which is shown in the 30 per cent alloy provided that the nickel is below about 25 per cent. The limits at which some precipitation of σ occurs will naturally be displaced by differences in the amounts of other elements present. For example, whereas an alloy containing chromium 25, nickel 20 per cent with 0·3 per cent of silicon showed no precipitation after being annealed for 1000 hours at 800 deg. Cent., the corresponding alloy with 3 per cent of silicon showed marked precipitation after the same treatment. On the other hand, it was found that variation in carbon content, such as may occur in commercial

alloys (i.e., up to about 0·3 per cent) was without influence.

Sigma in the Fe-Cr-Mn Alloys

The work of Burgess and Forgeng[14] (1938) and of Schafmeister and Ergang[15] (1939) shows that the σ region is more extensive in the alloys containing manganese (Fig. 4) than in those containing nickel. Whereas the σ phase can exist alone up to 10 per cent of nickel and no longer appears associated with γ in any alloy containing more than 35 per cent of nickel, the σ field extends to 35 per cent of manganese, and σ still continues to exist along with γ in Mn 64, Cr 20, Fe 16, the alloy of highest manganese content investigated by Schafmeister and Ergang. Not only is the σ phase found over a much wider range of concentration in the manganese than in the nickel alloys, but it is much more readily precipitated by a reheating of short duration, both of which facts serve to restrict the useful range of composition of the iron-chromium-manganese series and account for the lack of commercial interest in these alloys. An earlier investigation by Kluke[16] (1938) indicates that the effect of carbon up to 1 per cent is not very great; for alloys containing up to 20 per cent Mn with Cr 30 and C 0·6–1·0 per cent the following constitution was found :—

Up to 10 per cent manganese	α+carbide
From 10 to 15 per cent manganese ...	α+σ+carbide
Over 15 per cent manganese	σ+carbide

Sigma in Commercial Heat-Resisting Alloys

The chance of encountering σ in any commercial iron-chromium alloy cooled in the usual way is very small, but the conclusion of Cook and Jones that it may appear in alloys with 25 per cent of chromium annealed at 600 deg. Cent. is of importance as it indicates the possibility of its occurrence in commercial heat-resisting alloys which are maintained for a long time at elevated temperatures. Although, under these conditions, σ undoubtedly forms in the 35 per cent chromium alloy, iron-chromium alloys containing up to 30 per cent of chromium have been extensively used in Rezistal series of alloys, introduced in America twenty-five years ago by Dr. C. M. Johnson, contain 2·5 to 3·5 per cent of silicon, and the precipitation of σ in these alloys during exposure to temperatures between 595 deg. and 925 deg. Cent. was investigated in 1947 by Payson and Savage.[19] The formation of σ in these alloys is promoted by high chromium, high nitrogen, high silicon, low carbon and additions of titanium, columbium or zirconium. In high-silicon alloys with about Cr 24, Ni 13 per cent, or Cr 25, Ni 20 per cent, the formation of σ takes place slowly and is preceded or accompanied by precipitation of carbide. The ductility and notched-bar impact resistance are markedly reduced. Carbide precipitation alone may render the material brittle, but when σ is also present the deterioration is much worse. A higher carbon content, which has been suggested as a means of avoiding the formation of σ, may give rise to increased carbide precipitation and so not eliminate embrittlement. Payson and Savage do not regard the elimination of σ from these alloys as a major requirement. In their experience there have been very few service failures which could be attributed to the formation of σ. Although silicon definitely extends the range of stability and accelerates the formation of σ, its beneficial effect on resistance to oxidation at high temperatures is so great that it continues to be a desirable constituent. No addition could be found which would prevent the formation of σ in the 25 per cent chromium alloy in the presence of 0·5 per cent silicon; but alloys which have suffered deterioration can be restored by heating for a short time at about 1050 deg. Cent.

It has been suggested that the presence of σ in heat-resisting steels is, on balance, an advantage, as it is said to improve the strength of the material at high temperatures. A patent has been granted to Armstrong (U.S. Patent 2,225,730), which takes advantage of the hardening by precipitation of σ in Fe-Cr-Ni alloys with high silicon and some columbium. Avery and Matthews,[20] however, regard inherent freedom from α and σ as having an important bearing on the utility of heat-resisting alloys,

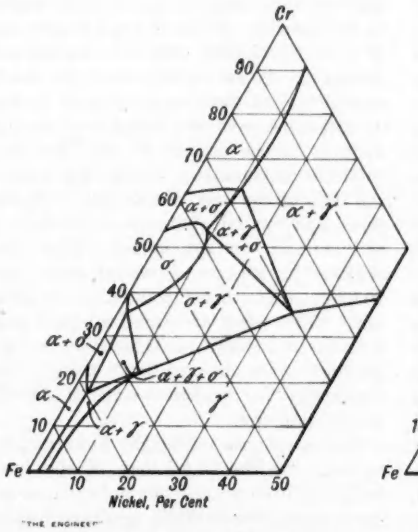


FIG. 3—*Isothermal Section of the Iron-Chromium-Nickel Diagram at 650 deg. Cent. (Kinzel and Franks, Based on Schafmeister and Ergang)*

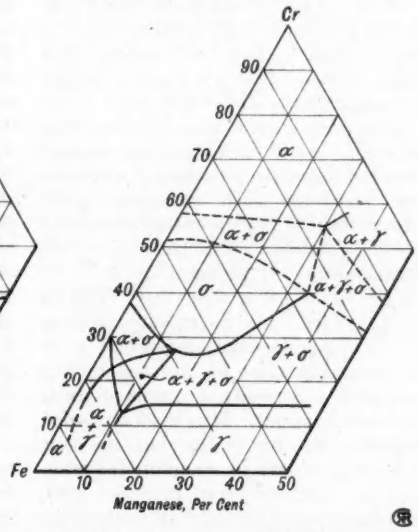


FIG. 4—*Isothermal Section of the Iron-Chromium-Manganese Diagram at 700 deg. Cent. (Schafmeister and Ergang)*

practice, and, in the experience of the Union Carbide and Carbon Research Laboratories,[17] no evidence of the formation of σ in bulk specimens of the 30 per cent alloy has been recorded in amounts sufficient to affect its properties. The embrittlement caused in alloys containing 20 per cent or more of chromium when held for any appreciable time, either during treatment or in service, at temperatures in the neighbourhood of 475 deg. Cent. cannot, according to the conclusions of Becket,[18] be attributed to the precipitation of σ. With this chromium content σ may, however, become an important constituent if silicon is present in considerable amount. The and therefore favour lower chromium and high nickel.

It was shown by the work of Franks, Binder and Bishop[21] (1941) and of Gow and Harder[22] (1942) that the presence of molybdenum strongly favours the formation of σ. The high-chromium-iron-molybdenum alloys developed by the Climax Molybdenum Company probably contain considerable amounts of σ, which results in brittleness at room temperatures.

Sigma in Commercial Corrosion-Resisting Alloys

A section of the iron-chromium-nickel diagram at 8 per cent of nickel (Fig. 5) indicates that the pure 18 per cent chromium alloy is just free from σ at all temperatures, assuming that equilibrium is maintained. A little more chromium, or the enrichment of α in chromium, results in the formation of σ, which, however, does not appear at ordinary rates of cooling, but only after relatively long annealing at the proper temperature. The 18 : 8 alloys are wholly austenitic and without free carbide only when quenched from a high temperature, and the chromium cannot be increased much

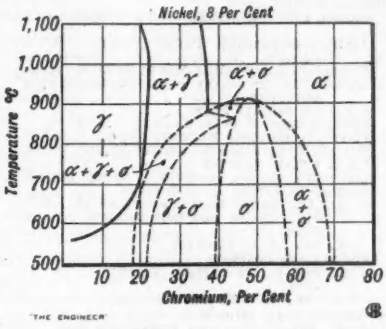


FIG. 5—*Section through the Iron-Chromium-Nickel Diagram at 8 per Cent Nickel (Kinzel and Franks)*

beyond 20 per cent if a wholly austenitic structure is to be maintained.

In the original 18 : 8 alloy it seems unlikely that the σ phase was in any way responsible for intergranular corrosion (weld decay) which is adequately accounted for by local impoverishment of the chromium content by precipitation of chromium carbide, and was corrected by small additions of stabilising elements to the low-carbon alloy; nor is it likely to be a factor of primary importance in the modified alloys of the 18 : 8 type, containing ferrite-forming additions, since it would not be present after normal heat-treatment and probably not to any important extent after ordinary welding procedure on thin plates. For information as to the occurrence of σ in complex alloys of this type, however, the papers[23] referred to at the beginning of this article should be consulted.

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TWELVE-PAGE SUPPLEMENT—THE BRITISH INDUSTRIES FAIR

NOTICE TO READERS

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BRITISH INSTITUTE OF MANAGEMENT

IN the middle of last week, at a meeting in the Senate House of London University, there was officially launched the new British Institute of Management. It is about eighteen months since Sir Stafford Cripps announced in the House of Commons that the Government intended to set up this body and that it would support it with grants up to £150,000 spread over five years. Subsequently announcements were made of the names of members to serve as the council of the new body and of the fact that Sir Charles Renold had been made its chairman. But the roots of the matter go much further back, to the time when the National Government was in existence. Two successive committees were then set up by the President of the Board of Trade. The first, under Sir Cecil Weir, enquired into the general position and established the case for a central institute in which all interests concerned with management could find a focus. The second was set up by Sir Stafford under the chairmanship of Sir Clive Baillieu, to formulate detailed proposals. It was composed of industrialists, trade unionists and educationalists, and it was this committee that recommended the Government to sponsor the formation of the Institute and which formulated the general pattern of its organisation. Last week Sir Stafford Cripps, who has been so closely concerned with all the steps taken to form the Institute, was able to be present to see it launched upon its public career.

There are certain techniques of management which a student may learn from books and articles. Book after book has, indeed, been written on facets of the subject. Our own shelves at this office contain numerous works on planning, estimating, rate-fixing, costing, time and motion study, payment by results, salesmanship, accounting, organisation and administration, &c. Many firms and organisations have developed methods of their own to suit their own particular problems, methods that have never been described in print. A great deal of the work of the new Institute must therefore lie in the study and discussion of all this information published and unpublished, and in its compilation into forms more accessible to and perhaps more digestible by practical managers. But though there are techniques of management, management is not a science. However excellent the techniques adopted, however good, on paper, the organisational methods, success in management fundamentally depends upon wise and tactful handling of human beings. Management is, therefore, an art. Moreover, since the wants of human beings vary according to the circumstances of a time, methods of management must change with the times. A hundred years ago when workers drawn from country to factory life had to learn the need for a different discipline if the work of the factory was satisfactorily to be carried out, management had to be authoritative. Nor, indeed, was that system so bad as its critics have often painted it. Have there ever been more satisfied, happier workers than those who laboured under the wise paternalism into which authoritarianism developed and which still persists to this day in a number of engineering firms? But, hand in hand with changing human ideas have gone changes in works processes. The skilled hand of the past took pride in the product that grew under his hands and worked hard to produce it. But the repetitive processes of a modern factory breed no such satisfying pride. Nor do we believe that monetary incentives are a wholly satisfactory substitute for pride of craftmanship. If productivity is to be raised by means other than that "fear of the sack" which no longer operates in these days of full employment, individual pride in craftsmanship must be replaced by the pride of all in the quality of a firms products and its rate of output. It is the job of good management not only to introduce the best-tried techniques and to maintain the standard of the machinery and processes used, but also to generate amongst all workers the spirit of working as a team.

The object of the new Institute, as it develops further towards a self-supporting basis independent of Government support, will be to improve the general level of management in this country by making known to all what are these human factors and managerial techniques that have proved themselves effective in raising output, cheapening cost and improving quality; to spread knowledge, that is, about managerial matters and so to make it possible for less well managed concerns to learn from the experience of the better managed. No engineer is likely to deny the potential value of such work. It parallels in a new field the invaluable work of similar nature carried out by the great engineering institutions in spreading knowledge about technical and practical advances in the art and science of engineering. There is much talk to-day amongst the less well informed of the inefficiency of British management. The need felt to set up this new Institute may in itself lend colour to such criticisms. It was therefore good to hear Sir Stafford Cripps, himself amongst the critics, remark forthrightly at the opening ceremony, "British management has done a good job since the war, as it did during the war, and we can stand comparison with managements in any other country in the world." The journal of the new Institute, its other publications, the researches that it plans to undertake, its influence upon education and its eventual establishment of standards of qualification for managers and of a code of professional conduct will, we believe, soon show other countries that, if, indeed, they have something to teach British industrial management they have, too, a very great deal that they can usefully learn from it.

HIGH FLYING

As we announced in a recent issue the international altitude record for aircraft, held for the past nine years by the Italian pilot Mario Pezzi, has been beaten by a British pilot flying a "Vampire" jet fighter fitted with a de Havilland "Ghost" engine. This new record, made by an aircraft which is a practical fighter and not a "freak" designed solely for high flying at the expense of other features, stands to the credit of Mr. John Cunningham, D.S.O., D.F.C., at 59,492ft, surpassing by some 3000ft that previously held by Italy and by 6000ft that achieved by the previous British holder, Flight-Lieut. M. J. Adam, in 1937. That the Italian record should have stood unchallenged for nearly a decade may in these days of rapid technical development seem surprising, but the intervention of the second World War is the sufficient explanation. A similar pause at the time of the first World War is shown in the graph recently published by one of our aeronautical contemporaries. The record altitude in 1914 is shown as standing at 20,000ft, and this remained unchallenged until 1920, when an American pilot raised it in a single jump to 33,000ft. Since then the honour has changed hands many times—usually by the moderate steps of 2000ft or 3000ft at a time.

For many years a height limit had been imposed by the physiology of the human body. It becomes difficult to breathe normal air at much over 20,000ft, and even when the pilot is helped by the provision of a supply of pure oxygen it is hardly possible to go beyond 45,000ft; the 1932 and 1934 records obtained by this means stood respectively at 44,000ft and 47,000ft. To achieve 50,000ft—as was done by Flight-Lieut. Swaine in a Bristol aircraft in 1936—required the novelty of a complete pressure suit, worn by the pilot and fed with pure oxygen at a pressure several pounds per square inch above that of the surrounding atmosphere. By such means the physiological limitation on altitude was removed, and the achievement of greater and greater heights became purely an engine and airframe problem. By the march of events, however, even the new pressure

suit became obsolete, since in modern high flying aircraft the pressure cabin gives the pilot all the protection he needs and has, in addition, the considerable merit of preserving him from the burden of wearing a very clumsy and heavy suit of clothes. Any further gain in altitude must therefore depend on the power plant, which is just as liable to oxygen starvation as is the human body. With so great an appetite it is out of the question to feed it with oxygen. The direct course is to provide more capacious superchargers, but these become over-heavy and elaborate for record-breaking when the height exceeds 50,000ft. Here it is that the new light gas turbine finds its opportunity. It now holds the new height record, and the path towards still further achievement looks not too difficult. During the full-day discussion on gas turbine problems organised by the Royal Aeronautical Society some two years since it was forecast that at least one aircraft type of the day, having a ratio of thrust to weight of 0·5, should be able to attain a ceiling of 55,000ft, and that if the thrust-weight ratio could be raised from 0·5 to 1·0—just enough to enable the aircraft to "sit on its tail"—the ceiling would rise to as much as 70,000ft. To get beyond that height, however, will not prove easy. It is true that jet fighters may, as a a matter of common practice, come to be equipped with rocket assisters, and with that door open something little different from a pure rocket type might essay to enter the race; if it did, heights of hundreds of miles, as the V 2 showed, would be readily obtainable. But those who draw up the regulations covering international record contests can be trusted to guard against that eventuality.

Apart altogether from questions of prestige in record breaking, it will be asked whether the attainment of such immense heights is really worth the effort involved. For civil aircraft it certainly is not, but on the military side equally certainly it is. Our fighter interceptors must always be able to outfly any possible invaders, and no range of either height or speed that they may conceivably have can be left unassailed. Some such invaders might be bombers, when for obvious reasons they must needs be dealt with faithfully. Some may be aircraft on photographic reconnaissance duty for which great height is essential; at 60,000ft the earth's horizon is 250 miles away and with really clear weather the "bird's eye" view could sweep the whole of the British Isles. Record breaking is not only good practice and good training for the Royal Air Force, but an important means of showing the world the high technical standard reached by some of our latest forms of defence equipment.

Letters to the Editor

We do not hold ourselves responsible for the opinions of our correspondents)

THE GAS TURBINE, 1910

SIR,—Some time ago I was given a number of copies of your very early journals, and in the issue of February 11, 1910, I was interested to note the reference in the editorial to the gas turbine.

I am sure that many other present-day readers will also be interested in the Editor's observations at that time, concerning power plant prime movers.

"It was inevitable that the success which has attended the steam turbine should turn the minds of inventors towards the problem of designing a turbine which will utilise in a similar manner the heat generated by the combustion of gaseous or liquid fuels. . . .

"It is easy but quite misleading to argue that as the steam turbine possesses merits in certain particulars that make it superior to the reciprocating steam engine, a turbine actuated by internal combustion must therefore possess corresponding advantages over the reciprocating gas engine. In point of fact, the thermal conditions of the steam and the gas turbine are as the poles asunder, while the mechanical considerations are also widely different, first, on account of the different appliances which will be necessary as the result of the differences in the cycles of operation, and next on account of the difference of the maximum temperatures to which the materials of the respective systems will be subjected. . . .

"If the practical difficulties in the way of making a successful gas turbine prove insuperable, or if the price to be paid for success proves prohibitive, either in cost, complication or convenience, is there no development possible which will make the reciprocating engine more suitable for large powers? The question of adaptability to large powers is really the governing . . . Meanwhile, one thing is certain, much water will flow beneath the bridge before the gas turbine as a practical commercial article emerges from the *ewigkeit*."

T. H. CARR

Shipley, Yorkshire, April 17th.

INSTITUTIONS AND THEIR MEMBERS

SIR,—I am sure that all members of the Institution of Mechanical Engineers will agree that something should be done to avoid the recurrence of such an incident as that referred to in your leading article of April 16th. I think, however, that in raising the question of the advisability of abolishing general meetings because of their generally unrepresentative character you have overlooked one of the most important advantages of such meetings, namely, that they afford the only opportunity for members to propose amendments to any proposition put forward by the Council. As the size of the Institution now renders a postal vote desirable in all matters of importance, I would suggest that every amendment which receives at least one-quarter of the votes at the general meeting should be included in the voting paper on equal terms with the original proposition of the Council. It is an affront to those who attend a general meeting that the postal voting paper should have been printed in advance—as was done in the present case—without regard to any expression of opinion by the members present at the meeting.

M.I. MECH. E.

April 26th.

Literature

SHORT NOTICES

Electrotechnology and Calculations. By M. G. Say. London: George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Price 6s. net.—This 159-page book is divided into two parts. The purpose of Part I is to outline the electrotechnical basis of phenomena that are important in heavy electrical engineering. Starting with modern conceptions of the nature of electricity and atomic structure the reader is introduced to the fundamental physical relationship between energy, work and power, followed by a survey of electrical units. This section leads on to a brief summary of the various effects of electric current which are put to use in electrical engineering. Part I is concluded by a general review of circuit theory introducing the ideas of vector algebra, and harmonic analysis to form a connecting link with Part II, which opens with the principles of network theorems illustrated by a number of worked examples. Symmetrical components, transients and impedance loci are introduced in the final sections with the help, again, of numerical examples. Recognising that every specific application of electrical science to engineering has its own special technology, the author has avoided the temptation to deal with any of them individually. By concentrating instead upon basic principles and method of approach the author has succeeded admirably in condensing the elements of an extensive subject into the compass of a single small volume.

Frequency Modulation Engineering. By C. E. Tibbs. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 28s. net.—Although frequency modulation has been used in Great Britain for special communication work and is being applied by the B.B.C. to an experimental broadcast service, information about the subject was until recently available only in the form of a number of scientific papers. The purpose of the book under review, therefore, is to provide students and radio engineers with a single volume containing a concise and easily digestible survey of the whole field of frequency modulation engineering. If, as suggested in the foreword by L. H. Bedford, the author's theoretical exposition of the subject is not above criticism, this fault must be offset against the merits of a practical approach to the engineering side of frequency modulation engineering. In the early chapters of the book the fundamental properties of a frequency modulated wave are discussed and the methods of suppressing interference are treated at some length. The subjects of ultra-short-wave propagation and aerials are briefly summarised, while the bulk of the book is concerned with a description of the technique used for frequency modulation and reception, with emphasis on circuits of commercial equipments, of which the component values are indicated wherever possible. The value of the book is by no means impaired because of the fact that the commercial apparatus described is for 40–50Mc/s, whereas the B.B.C. has now chosen 90Mc/s as the region for frequency modulation broadcasts.

Modern Rubber Chemistry. By H. Barron, Ph.D., B.Sc., &c. London: Hutchinson's Scientific and Technical Publications, 47, Prince's Gate, S.W.7. Price 36s. net.—The first edition of this book was published some ten years ago, and in preparing the new edition the author has obviously gone to much trouble to explain in a clear, lucid and concise way the scientific principles behind rubber manufacture as at present understood. The book is divided into five main sections—General Considerations, Scientific Aspects of Raw Rubber, Processing of Rubber, Scientific Aspects of Vulcanised Rubber, and the Technology of Rubber—the chapters in each section concluding with a comprehensive list of references. Both technologists and students will find this book a valuable addition to the published literature on the subject of natural rubber.

BOOKS RECEIVED

Britain's Way Out. By A. Grant McGregor. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, W.C.2. Price 1s. 9d.

Electricity Meters and Meter Testing. By G. W. Stubbings. Second edition, revised. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 16s.

Breathing in Irrespirable Atmospheres. By Robert H. Davis. London: Saint Catherine Press, Ltd., 29, Great Queen Street, Kingsway, W.C.2. Price 25s.

Boiler-House and Power Station Chemistry. By Wilfrid Francis. Second edition. London: Edward Arnold and Co., 41 and 43, Maddox Street, W.1. Price 21s.

Automobile and Aircraft Engines: Vol. I, The Mechanics of Petrol and Diesel Engines. By Arthur W. Judge. Fourth edition. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, W.C.2. Price 25s.

Obituary

SIR WILLIAM REAVELL

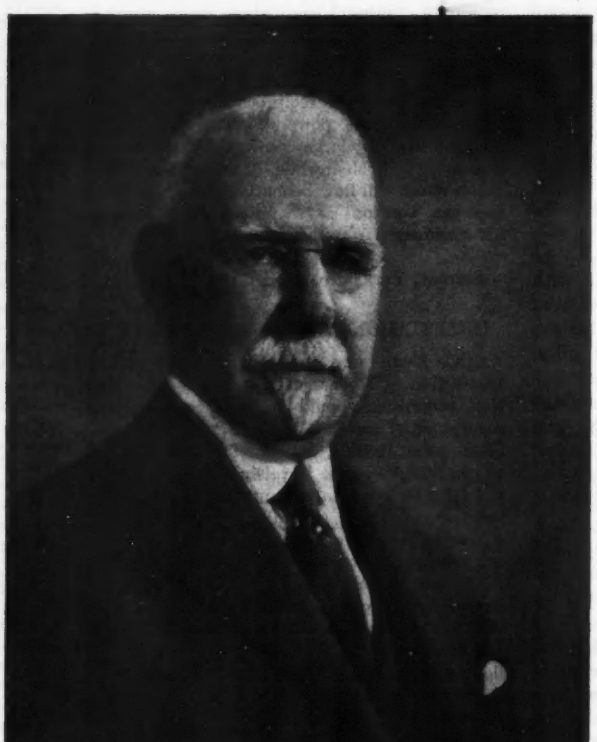
LAST Sunday morning, April 25th, the death occurred, at his home, "Broadwater," Ipswich, at the age of eighty-two, of Sir William Reavell, the founder, managing director and chairman of Reavell and Co., Ltd., of Ranelagh Works, Ipswich. All those many engineers who knew him, even if only by way of acquaintance, will experience a severe sense of loss by his passing. For Sir William had been a leader amongst engineers for so many years that younger men cannot remember the time when his name did not carry a major significance, and he was, moreover, a man of a stamp that this twentieth century seems unable to raise. He not only founded his own business, and wisely guided it, living to see it obtain its year of jubilee, but by his unselfish work for the British Engineers' Association, the British Standards Institution, and the Institution of Mechanical Engineers he did more than most men for the advancement and welfare of the profession he chose.

William Reavell was the second son of the late Mr. George Reavell, and he was born on March 2, 1866, at Horsham, in Sussex. He received his early education at the Alnwick Grammar School, more affectionately known as the Duke's School, and in 1882 he was apprenticed to the St. Peter's Works of Hawthorn, Leslie and Co., Ltd., at Newcastle-upon-Tyne. He completed his training in 1887. But for two years, until 1889, he stayed on as a marine engine draughtsman, pursuing further technical studies at evening classes at the Rutherford College of Armstrong College, at Newcastle-upon-Tyne.

In 1889 he came to London, with the idea of furthering his technical training, and he obtained a position with Maudsley, Sons and Field as a marine draughtsman. There he further widened that knowledge of battleship machinery and marine engines for passenger and cargo vessels that he had gained in Newcastle. Meanwhile he continued to attend evening classes, going to the Birkbeck Institute and the City and Guilds Technical College, Finsbury.

In 1891 there came another change. He joined the firm of Babcock and Wilcox, Ltd., as a designer of marine water-tube boilers. In that firm his business capacity was soon recognised, and he became manager of the marine department. He remained with the firm until 1897. In that year he was appointed the general manager of the Lambeth works of Peter Brotherhood and Co. But, stirred by ambition, he relinquished that position a year later with the intention of founding his own business.

The firm of Reavell and Co. was started primarily to build the Scott engine, and the late Mr. W. H. Scott, Sir William Reavell's brother-in-law, was a founding director of the company. The "Scott" engine was quite successful, but it failed to meet the keen competition of the high speed forced lubrication engines, particularly for the higher powers which were then in use for power station work. The smaller double-acting steam engine was also manufactured by the firm alongside the "Scott" engine, and attention was also paid to the quadruplex air compressor, which was patented about 1899 and which was marketed in 1900. At the turn of the century the diesel engine was being developed both in this country and on the Continent. William Reavell knew the late Dr. Rudolph Diesel personally. No doubt it was for that reason that he became interested in the possibilities of the new engine and its needs. About 1905 the firm developed a high-pressure air compressor for oil engine work, which was supplied to the British Westinghouse Company, of Manchester, and Willans and Robinson, of Rugby, firms then constructing diesel oil engines. Abroad, air compressors of Reavell design were supplied to Carel Frères, of Ghent, Belgium, and Franco Tosi, of Legnano, Italy. For many years thereafter there were regular compressor orders from these and from other firms. Soon the design of a high-pressure marine reversible air compressor was undertaken. It found employment both in this country and by firms on the Continent. In 1907 a new mechanism for converting rotary motion into reciprocating motion was patented, and formed the basis of a new series of small two-stage compressors. The same year Sir William introduced two-stage, high-pressure air compressors, and there followed a patent for two-stage compression in a single cylinder. In 1910 the "V" class three-stage air compressor was produced and patented. These products soon gave to the name Reavell an established reputation for compressing and exhausting plant of many kinds. The scope of the work undertaken continued to expand, and during the 1914–1918 war Sir William was responsible for patents on gun compressors and improvements to the hydroplanes of submarine vessels. He also introduced the rolling drum compressor and exhauster, which still continues to be made by the firm.



SIR WILLIAM REAVELL

Sir William's interests in the scientific institutions began in 1896, when he was made a member of the Institution of Naval Architects. He was then interested in water-tube boilers and took his part in the great "battle of the boilers." In 1913 he contributed to that Institution a paper on "Compressed Air for Working Auxiliaries in Ships Propelled by Internal Combustion Engines." He joined the Institution of Mechanical Engineers as a member in August, 1907, became a member of Council in 1917 and a Vice-President in 1923, and served his term of office as President in 1926. He was subsequently honoured by his election as honorary life member in 1932. In 1929 Sir William was chosen as one of that Institution's two delegates to the World Engineering Congress held in Tokio, Japan.

Quite early in his career, Sir William became interested in the establishment of engineering standards and his major contribution (amongst very many hardly lesser ones) to the British Standards Institution was his work on "Keys and Keyways." The committee on that subject was formed at his suggestion, and he was made its chairman. He was responsible for research work which was carried on in connection with the subject and he presented the findings of that research, in a paper he read before the Institution of Mechanical Engineers in 1910. In 1929 he succeeded the late Sir Henry Fowler as Chairman of the Mechanical Industry Committee of the British Standards Institution, and he continued in that office until 1944. He was Chairman of the Engineering Divisional Council from 1931 to 1944, and chairman of the General Council in 1936. He also served on many other committees. Sir William was thus closely associated with the Institution for close upon forty years, and as late as 1944 he was co-opted as a permanent member of the General Council.

In 1930 he was elected President of the British Engineers' Association and he served in that office six years until 1936, longer than any other President. He succeeded the late Sir Gilbert Vyle in 1930 and when he retired in 1936 Lord Dudley Gordon presented him with a gift of silver plate, as a token of the Association's appreciation of his work. About 1930 Sir William also served two years as President of the Association of Engineers-in-Charge. In 1938 his many national services were recognised by the King's bestowal of a knighthood in the New Year Honours.

At home in Ipswich he found time for work on the Town Council, and was for a time Chairman of the Electricity Supply and Tramway Committee, and he improved the water supply to Ipswich by introducing oil engine driven pumping plant at the Whitton waterworks. He was a founder member of

the Ipswich Engineering Society, which celebrates its jubilee next year.

Everyone who worked with Sir William on committees and councils, or sat under him as Chairman or President, could not fail to be impressed by the accuracy with which he came prepared for his work. He took infinite pains to post himself fully in all the details of the agenda, and was never at fault on any point that might be raised in debate. Such thoroughness was characteristic of the man. He was a tremendous worker and in his own business he made himself conversant even with the minutiæ of its affairs. Whilst he was never a brilliant speaker, he invariably held his audience in the hall or round the table by the logical clearness of his arguments and by the patent knowledge of his subject. The services that he rendered to the British Engineers' Association, and the British Standards Institution, no less than to the Institution of Mechanical Engineers, will not soon be forgotten by all those, now mostly elderly people, who acted with him.

I.E.E. Kelvin Lecture

At a well-attended ordinary meeting of the Institution of Electrical Engineers in London on Thursday, April 22nd, Dr. B. H. C. Matthews, C.B.E., M.A., Sc.D., F.R.S., delivered the thirty-ninth Kelvin lecture on "The Nervous System as an Electrical Instrument."

Dr. Matthews' lecture was preceded by the presentation of certificates of Honorary Membership to Colonel Sir Thomas Purves, O.B.E., and Admiral of the Fleet Sir John H. D. Cunningham, G.C.B., M.V.O., and the Faraday Medal to Professor Marcus L. E. Oliphant, F.R.S.; these awards were briefly announced in a Journal note in our issue of January 23, 1948.

The presentations were made by the President, Mr. P. Good, C.B.E., who then introduced the lecturer and reminded his audience that the Kelvin lecture was inaugurated in 1908 for the dual purpose of helping members of the I.E.E. to keep in touch with the latest developments in the adjacent realm of physics, and at the same time to commemorate the name of Lord Kelvin. Dr. Matthews (said the President) was a distinguished scientist who had spent many years investigating electrical phenomena in the nervous system and had developed a number of novel methods of applying electrical measurement technology to assist him in these studies. For several years, also, he had done research work on the physiological effects of flight for the R.A.F. and in 1935 as British member of the International High Altitude Expedition for physiological research he had worked for six months at high altitudes in the Andes. At present Dr. Matthews was serving on the flying Personnel Research Committee of the R.A.F., and was consultant to the R.A.F. in applied physiology.

Dr. Matthews introduced the subject of his lecture by showing that the nervous system, which was analogous to an extremely sensitive and complex electrical communication system, could be simplified by analysing its elements. In a simple physical event these elements involved essentially the detection of the event, by the eye, for example; the transmission of an appropriate electrical signal along a sensory nerve fibre to the spinal cord; the retransmission of a suitable electrical signal along motor nerve fibres to the required muscles or glands, &c. Dr. Matthews showed how the membrane hypothesis had been developed to explain the transmission of current signals along animal nerve fibres. He outlined the history of the methods used for measuring and recording these impulses and indicated the extent to which practical knowledge benefited by parallel progress in the technique of electrical measurement, with the introduction, for example, of valve amplification, and the cathode ray oscillograph. With the help of slides the lecturer demonstrated how a steady physical event produces a train of pulses in the nerve fibres at a frequency depending on the initial sensory event, how the frequency falls with time and how the sensory organs responded to change rather than to the absolute value of physical event. Thus the eye without any datum for calibration purposes was a poor form of measuring instrument. It had, however, a useful range that was unmatched by man-made measuring instruments, since it could adapt itself to function satisfactorily in response to energies ranging relatively from 1 to 10^9.

At the end of the lecture a vote of thanks to Dr. Matthews was proposed by Colonel Sir A. Stanley Angwin, seconded by Professor E. B. Moullin and carried with acclamation.

London Transport Developments

Speaking at a Press reception on Tuesday last, Lord Latham, chairman of the London Transport Executive, outlined some of the technical developments that are now in hand or are being planned with a view to improving the efficiency of London's passenger transport services. Dealing with road services, he said that London Transport engineers were studying further developments of the design of bus transmission systems, and were also conducting research aimed at the improvement of the oil engine to a point where it would be equal, in silence and smoothness of running, to the modern petrol engine. Lord Latham stated also that developments were in hand for improved suspension and that a large-scale experiment in the use of the wider 8ft buses was to be made. Other matters of special interest mentioned by Lord Latham were the reorganisation of the Chiswick Works, designed to enable bus overhaul to be carried out on the most efficient quantity-production lines, and a new design of garage lay-out, an example of which was to be built at Garston, near Watford.

Turning to the railway side, Lord Latham briefly surveyed London Transport's heavy programme of work in railway construction, signalling and permanent way. The resignalling of the Piccadilly Line, which would be begun this year, would be an interesting example of the large-scale use of speed-control signalling to overcome the effect of disproportionately long stops at certain important stations and thereby make possible more frequent trains. As to track improvements, Lord Latham said that apart from track renewals, there was being carried out a systematic programme of realignment of curves, stabilisation of clay embankments and cuttings, and better methods of track drainage.

Finally, Lord Latham announced that a research and development committee had been set up by the London Transport Executive. The chief engineering officers of the undertaking were members of that committee, the task of which was to promote general technical development and to initiate fundamental research into matters likely to affect the efficiency of all operations. Recent examples which Lord Latham mentioned were research into the design of track components, and the introduction of the science of soil mechanics in relation to bank cutting slips. He said that, in co-operation with the Building Research Station of the D.S.I.R., experiments were being carried out at Stanmore entailing electro-chemical hardening of the slopes of a cutting by methods similar to those adopted in electro-osmosis.

Packaging Naval Aircraft

It is announced by the Admiralty that the first sizable shipment of naval aircraft packaged by the sprayed envelope method of preservation was recently despatched in the Light Fleet Aircraft Carrier H.M.S. "Vengeance."

During the war difficulty was experienced in the protection of aircraft which were being shipped overseas. Even when packed in wooden cases the effect of a moist salt-laden atmosphere caused rapid deterioration of the structure by corrosion. As a solution to this problem the American forces shipped overseas as deck cargo large numbers of aircraft which had been entirely coated by various substances applied by spraying. These coatings were found to be extremely effective in preventing corrosion, and they could be either washed off or removed by stripping off the rubber-like skin.

Towards the end of the war, the British Admiralty took steps to obtain a suitable material manufactured in this country, from which suitable coatings for preservation could be made. The material used was a chlorinated polythene which was developed during the war by Imperial Chemical Industries, Ltd., under the name "Halothene," for preservation purposes. On Admiralty initiative, this material was adapted for preserving aircraft, in a manner similar to that which had been found to be so successful in the case of American aircraft. At the end of 1945 three aircraft so coated were shipped to Australia. Since that time the technique of applying the sprayed material had been developed at a naval establishment, and following a further experimental shipment, the results of which were remarkably successful, it has been decided that all future aircraft shipped abroad in aircraft carriers shall be preserved by this method. On reaching their destination the aircraft can be stored under tropical conditions, without attention, for considerable periods. In handling aircraft so preserved, care must be taken not to break or damage the envelope. Should, however, the envelope become perforated, it can be repaired without difficulty, preferably as quickly as possible, so that moist air does not enter the aircraft. To prevent such damage or at least to minimise it, it is usual to place in the aircraft a small quantity of desiccant so that any moisture present is absorbed.

It is considered by the Admiralty that the development of the sprayed envelope method of preservation has solved a serious problem in the maintenance and storage of naval aircraft, especially when required overseas. The possibility of being able to store aircraft without attention should lessen the difficulties of maintaining a sufficient number of reserve aircraft overseas in a condition ready for service at a minimum cost in manpower.

Pre-Stressed Concrete

Mr. C. W. Key, Minister of Works, speaking recently at the opening of the Building Trades Exhibition at Manchester, referred to high building costs and shortages of steel and timber. One of our principal objects must be, he said, to reduce costs and to relieve demands on scarce materials by the use of new methods and new products. A small exhibit arranged by his Ministry showed a new material with great potentialities, pre-stressed concrete. The limitations of concrete as a building material unless it were strengthened by extensive steel reinforcement, were well known. For some time, however, there had been developed on the Continent a method of reinforcing which involved pre-stressing or post-stressing of the concrete by steel wires on which a high tension had been placed artificially, maintained by the bond of the concrete or by other means. The system required only about 20 per cent of the steel used in ordinary reinforcing and lent itself to the manufacture by mass-production methods of articles varying in size from 1in planks to 70ft long beams.

Continuing, Mr. Key stated that pre-stressed concrete had great potentialities, some of which were illustrated at the exhibition. The method had been employed in the concrete sleeper programme of the Ministry of Works, and plans were being made for the production in 1949 of pre-stressed concrete joists for houses. It was hoped that by such means the difficulties caused by the timber shortage would in some measure be overcome. Other uses for pre-stressed concrete included electricity transmission and telegraph poles, piles and sheeting for harbour works, members for large-framed buildings, and even complete bridge spans. It was a material resilient like timber and strong like steel, and the manufacturing process was not complicated.

The "Shervick" Industrial Tractor

No. II—(*Continued from page 401, April 23rd*)

IN our first article we described and illustrated the new "Shervick" industrial tractor, which has been designed and built by Vickers-Armstrongs, Ltd., for the Oversea Food Corporation's East Africa groundnut scheme. The tractor is now being produced at the Elswick Tank Works at Newcastle-upon-Tyne. We now pass to the special ground-clearing implements which have been designed by Blaw-Knox, Ltd., of Clifton House, Euston Road, London, N.W.1, and were constructed at the company's Rochester works.

TRACTOR AND STUMPER PREPARING TO DIG IN

TREE STUMP LIFTED

General Implement Design

About the same time as the United Africa Managing Agency and the Unilever engineers approached Vickers-Armstrongs, Ltd., in connection with the problem of the tractor, Blaw-Knox, Ltd., was asked to undertake the design of all the ground-clearing equipment needed for the scheme. Throughout the various stages of development there has been the closest collaboration between the engineering staffs of the two firms.

It will be recalled that the "Shervick" tractor is furnished with two square trunnion flanges at the sides of the machine, for attaching the implements. To raise these implements a Blaw-Knox double drum power control unit at the rear takes its power through the transfer drive.

The first implement to be completed was the treedozer, a view of which was given in our first article. It embodies the basic principles of the standard design of American treedozer, having, in addition to the tree-felling arm, a front windrowing blade. The U-shaped frame for the windrowing blade is at the bottom box section. The blade is attached to the frame in a manner generally similar to that usually adopted for an angle-dozer blade. The shape of the blade was so made that when going through woodland scrub the machine can windrow the scrub to either side of the tractor, leaving a clear passage. The blade consists of a straight section about 2ft 6in in length at the front, with swept-back wings at each side, which extend beyond the outside of the tractor tracks.

The tree-felling arm is mounted on the same trunnion flange, and is above the windrowing frame. The overhead construction not only protects the driver from falling tree limbs, but forms the support for the sheaves of the operating ropes. All controls are neatly arranged alongside the driving controls.

As a result of the early experience obtained in tree-felling in Surrey, combined with information obtained by an actual survey of the country to be cleared in East Africa, improvements were made which were embodied in the second model. Both models were on view at the Bagshot demonstration. The first was illustrated in our last article and the second, shown herewith, is faster in operation and gives a better field of view for the operator. The two views we reproduce show the tractor fitted with the new type of tree-felling arm and a stumper blade.

The U-frame to which the stumper blade is attached is so made that by removing two pins the blade can be taken off, and an angle-dozer blade attached by inserting three pins. By this means the tractor can be made to serve two purposes, as occasion demands.

The tree-felling arm is also of new design. It consists of a straight arm instead of the earlier cranked arm, and it is narrowed at the front to take a 4ft wide blade with a knotched edge. This blade makes the initial contact with the trunk, and the uprooting of the falling tree is accelerated and completed by the digging action of the lower stumper blade already referred to. By this means, felling and stumping is accomplished in one operation, stumping being the uprooting of stumps left in the ground after felling by the axe or the saw. Two views given herewith show the tractor approaching the stump, with a raised blade. Later the blade is lowered so as to dig in to a depth of, say, 4ft, an operation which is started between 4ft and 6ft in front of the stump, according to its diameter. In the second view we show the uprooted stump, which is turned completely out of the ground by the movement of the oncoming tractor, and the upward lift of the stumper blade. In actual tests made with tree stumps from 9in to 2ft in diameter, no difficulty was met with. With stumps averaging 18in in diameter a rate of removal of one stump a minute was attained. In the tree-felling operations which were referred to in our first article, the machine was shown to be able to deal with any tree having a diameter up to 5ft at the base, and not only to uproot it but to push it completely clear of the hole or roll it to one side.

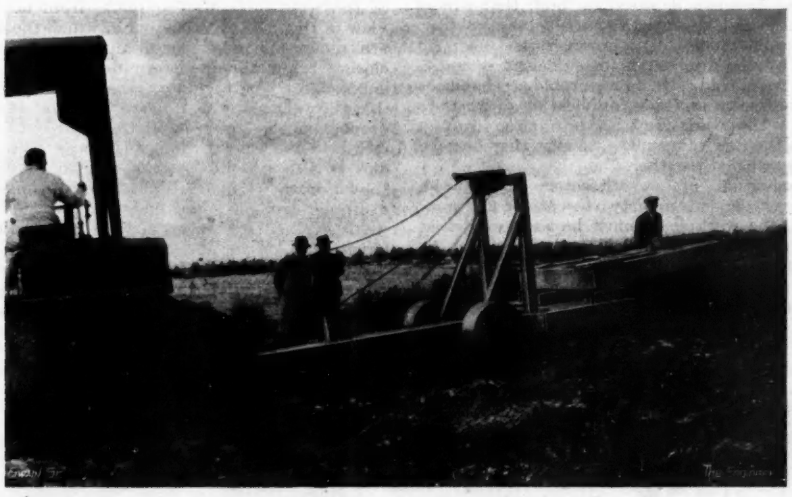
The Root Cutter

The root cutter is of special interest as it represents an entirely new aspect of land-clearing equipment, which has been introduced in order to meet the particular ground conditions obtaining in East Africa. It was originally made to fit on to a standard Blaw-Knox R.60 ripper body. The problem to be solved was that of dealing with the mass of tangled roots running laterally and vertically in the ground, after the scrub had been removed.

TRACTOR TOWING ROOT CUTTER

No existing land-clearing equipment was able to deal with these conditions, and a new root-cutter had to be designed. As will be seen from the illustrations we reproduce, the cutter consists of a top horizontal frame of box section with two rear posts having a sharp knife-like front edge, and at the foot of each post a triangular-shaped flat knife-blade. The two blades are slightly staggered so that an uncut root can pass between them and so prevent clogging. In front of each vertical post is another arm, carrying a 28in diameter disc with a sharp cutting edge. These discs are able to deal effectively with the remaining lateral roots. Any root or rootlet below the lower edge of the disc is caught and severed by the sharp edge of the rear posts. In the version shown, the width between the posts carrying the triangular knife-foot is about 2ft 9in.

ROOT CUTTER SHOWING KNIVES AND DISCS



ROOT CUTTER IN OPERATION

In demonstrating this implement it was established that the root cutter can sever all the roots remaining in the ground, and it can at the same time remove unlifted stumps, thereby performing the two operations of stumping and root-cutting at one time. The shape of the knives and discs promotes a sub-soiling action, which makes it possible to employ the cutter for certain agricultural operations, which usually have to follow land clearing. The actual tests made with this new machine in East Africa will be awaited with great interest.

A larger version of the root-cutter was also seen at Bagshot, and was put under test the day following the main demonstration. It has the same arrangement of triangular knives attached to vertical posts, with discs in front, but the width of the machine has been doubled and the distance between the two rear posts is about 4ft 9in. The larger machine gave, we understand, very satisfactory field results; it did not clog in any way, and the tractor was well able to tow it. Further development of the root-cutter design will take place as more knowledge of the actual ground conditions in Africa is gained. One root-cutter has already been shipped to Africa, and experimental results are awaited at an early date.

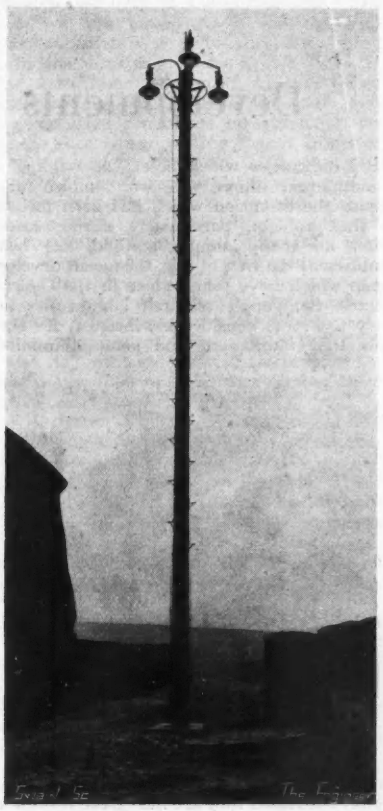
The Root Rake

The final operation prior to planting is to rake the ground clear of all roots which have been broken up by the cutter. This operation was demonstrated by using a Blaw-Knox rake 16ft in length with sixteen tines, each a foot apart. The tines are broad and have a length of about 4ft 6in. Good results were shown at the demonstration but this implement is still in its early stages of development.

Lighting at King's Cross Goods Yard

A COMPREHENSIVE scheme for the improvement of lighting is now in hand at the King's Cross goods yard of the Eastern and North-Eastern Regions of British Railways. In re-lighting this yard, consideration was given to the problem of giving the maximum overall illumination possible and still keeping within economic limits of expenditure, both for installation costs and annual running charges.

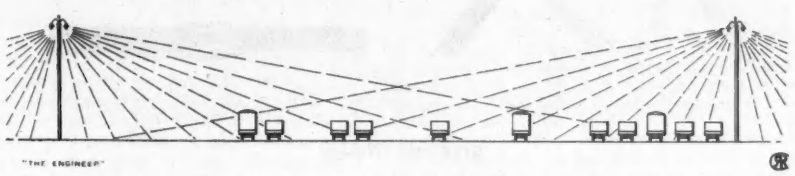
Prior to the 1914–18 war the lighting installation of King's Cross goods yard was by means of arc lamps mounted on 20ft posts, which were installed near the principal point positions. In 1916 the arc lamps were replaced by 500-W tungsten filament lamps.



EXPERIMENTAL 60FT LAMP STANDARD

As the work of the yard increased, and to meet the need for improved lighting, consideration was given to the installation of additional poles for mounting additional lamps, but a survey of the yard revealed that few sites for the poles existed. Attention was therefore given to the possibility of lighting the entire yard by means of a comparatively small number of high poles for which sites could be found. These high poles would carry lamps of high wattage arranged in clusters, to provide good background illumination throughout the yard, the use of poles of 20ft being limited to positions where intense local lighting is called for.

In 1946 two 60ft poles were installed experimentally in the goods yard. One of these poles was equipped with tungsten filament lamps of 1000W, set in prismatic lanterns and arranged in a cluster of three, and the second pole was



ARRANGEMENT OF 60FT LAMP STANDARDS

similarly arranged, but with 400-W mercury vapour lamps. The mounting height of the lamps in both cases was 50ft above rail level.

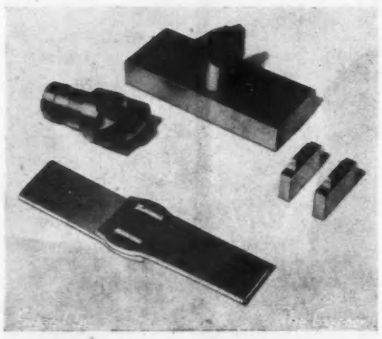
This form of lighting proved to be highly successful, and as a result of the experiment it was decided to install throughout the yard 60ft wooden poles, spaced approximately 300ft apart, equipped with 400-W mercury vapour lamps in "Holophane" bi-way refractor lanterns arranged in clusters of three. In one or two positions near signals the same type of lanterns have been fitted with tungsten filament lamps. For the main lighting of the yard, however, it has been possible to use mercury vapour lamps and take advantage of the higher light output efficiency of such lamps.

The light distribution between two adjacent poles as now arranged is suggested in the accompanying drawing. The general lighting effect produced throughout the yard is similar to full moonlight and the average illumination at ground level is 0·25 foot candles.

It should be noted that in lighting goods yards such as that of King's Cross the reduction of shadows to a minimum is as important as the provision of adequate illumination. This factor, together with economic considerations, has led to the adoption of poles having a mounting height of 50ft and fitted with a simple lamp-raising and lowering gear to facilitate cleaning and maintenance. Only part of the goods yard has as yet been equipped with the new lighting and installation work is proceeding on the remainder.

Developments in Cold Welding

THE difficulties which beset the welding of aluminium alloys are well known and, despite the attention which has been focused on the problem, particularly during recent years, no really simple method has been established. In view of this, the recent developments which have taken place in the General Electric Company's research laboratories are likely to arouse considerable interest, for they show that aluminium and some aluminium alloys can now be cold welded easily and reliably, provided they are first given a suitable surface treatment.



SIMPLE DIES AND SPECIMEN WELD

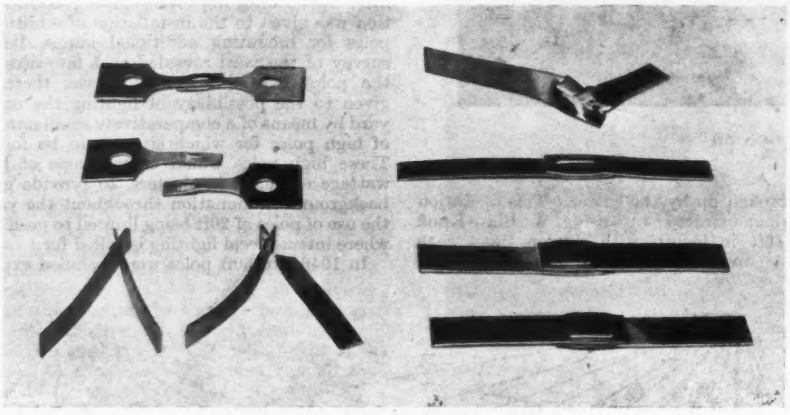
Cold welding is not, of course, new, but attempts to extend its use have not hitherto aroused much interest, probably because attention has been directed in the main to copper, which can easily be joined by soldering and brazing. Thus, cold welding has only been considered in situations in which it was desirable to avoid heating.

In brief, cold welding is a process whereby ductile metals are welded by pressure alone, the pressure being applied to the workpieces by specially designed dies which are mounted in a suitable tool, such as a hand press. Our first illustration shows these dies in their simplest form suitable for making short, straight welds, such as that shown in the foreground. A number of test strips welded by these dies can be seen in the second illustration. It will be noticed that those specimens shown tested to destruction have parted in the parent metal around the weld and not across the weld itself. In the upper right hand corner is shown a copper to-aluminium weld, the technique for which is referred to below.

At first sight it seems remarkable that so simple a treatment should produce such satisfactory welds. The technique involved, however, can be compared to the blacksmith's method of welding iron. In that process the metal is heated and thus made plastic so that it will flow when further worked by pressure or hammering; it seems, in fact, that a flow of material is essential to satisfactory welding.

Ductile metals can, however, be made to flow by the application of sufficient pressure, even when cold. Given a suitable arrangement of workpieces and dies, application of pressure brings the work surfaces into close contact while the flow takes place, so that they become solidly welded together.

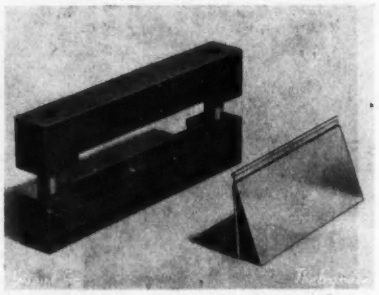
Production of a satisfactory cold weld, however, depends upon two essential conditions. First, the workpieces must be so treated that two uncontaminated metal surfaces can be brought into intimate contact between the dies. In other words, the oxide film on the surface of the aluminium must be removed, and a substantial part of the work carried out in the G.E.C. research laboratories was concerned with determining the best means of performing this operation.



SPECIMEN WELDS

Further, once the surfaces have been properly treated, the reformation of the oxide film, although it begins at once, is not rapid. Therefore, provided the surfaces are kept clean, satisfactory welds can be made within twenty-four hours of such treatment. Cleanliness of the surfaces is extremely critical, however, as even the contamination conveyed by handling will invariably prevent a weld from forming.

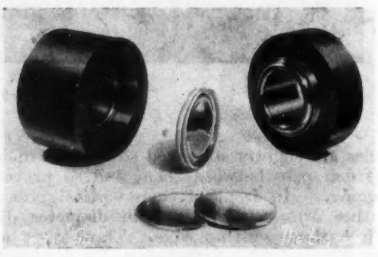
The second condition is that the pressure must be applied over a comparatively narrow strip, and in such a manner that the metal can flow away from the weld at both sides. This state of affairs is achieved by applying the pressure between suitably constructed dies. These requirements evidently impose some limits on the welding of complicated forms.



DIES AND SAMPLE LONG STRAIGHT WELD

A considerable displacement of metal is necessary to obtain a good weld. Normally expressed as a percentage of the combined thickness of the work, this displacement is conveniently measured by the reduction in thickness produced by the pressure. Obviously, a certain minimum reduction is necessary to produce a sound weld, but once this limit has been reached, it is clearly undesirable that further reduction should be allowed; such action would merely reduce the strength of the weld by removing metal from it. In view of this, the press or tool in which the dies are mounted, must be so constructed that closing below the predetermined minimum is impossible. Furthermore, it has been found that the required percentage reduction increases proportionately with the thickness of the metal to be welded, unless the width of the dies is also increased. The unmounted dies shown on the right of our first illustration, for example, are $\frac{1}{4}$in wide, and give satisfactory welds in $\frac{1}{16}$in thick sheet, as illustrated in the foreground.

From these basic ideas, three somewhat different techniques have been evolved, and all applications so far envisaged can be traced to one or other of them. The first is the long, straight weld, the dies for which are illustrated above, alongside a specimen weld. Another photograph reproduced herewith shows the second variant—the ring weld, the discs from which it is made and the dies required. It will be observed that the metal inside the weld has been formed into a smooth convex surface. Since this curvature results from the flow of metal necessary to make the weld, it is, in fact, difficult to keep this area flat when using a cold welding technique.

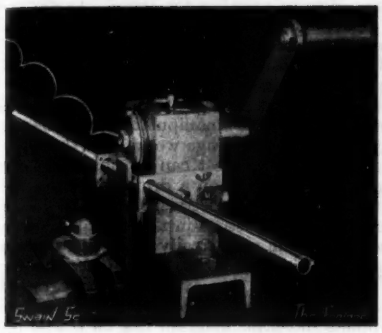


RING WELD AND TOOLS

The third and last technique, continuous seaming, is shown in the next two illustrations as applied to the making up of tube, an applica-

tion for which it is particularly suitable. Comparison between the section of tube before welding (right) and after welding (left) will reveal that the metal outside the weld has been trimmed off. This trimming is evident in the view which shows the machine in operation. A further interesting development is that simple dies can be mounted in suitable hand tools which are quite satisfactory for producing cold welds in the thinner gauges of metal.

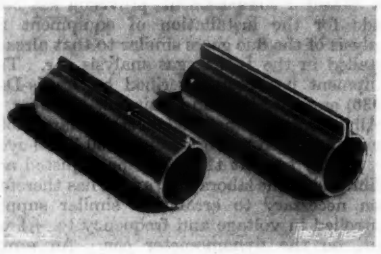
The simplicity of cold welding arises from the ease with which ductile metals flow under



CONTINUOUS SEAM WELDING

pressure, while the limitations of the process also result from the same property. Although nearly all ductile metals can be cold welded the process is actually useful with only a few of them.

It is also interesting to note that by using special dies, whose two components have different surface areas, it has been found possible to weld copper to aluminium. A test specimen showing an aluminium strip joined to a copper strip is included (as mentioned above) in the upper right-hand corner of our second illustration. This particular technique may well



SEAM WELDING OF TUBE

prove to be useful in making electrical connections.

These new developments, which have been fostered by the General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2, deserve the attention of all industries which use aluminium materials. In the course of time the new process may even lead to considerable revision of current production methods. The importance of cold welding may well be further enhanced by the encouragement which it can give to the replacement of steel by aluminium in certain applications, a most desirable object in view of the present insatiable demand for steel.

BRITISH CAST IRON RESEARCH ASSOCIATION.—The first post-war refresher course held by the British Cast Iron Research Association was held at Ashorne Hill, near Leamington Spa, by courtesy of the British Iron and Steel Federation, from April 14th to 17th. More than 200 representatives of member firms, together with students of the National Foundry College and members of the Association's staff, attended the course. The visitors were welcomed by the President of the Association, Dr. Harold Hartley, and lectures were given by the staff and by Mr. J. W. Gardom, Mr. L. W. Bolton, and Mr. A. E. Probst.

The British Electrical and Allied Manufacturers' Association

THE thirty-seventh annual general meeting of the British Electrical and Allied Manufacturers' Association (Inc.) was held in London on Thursday, April 15, 1948. In the absence abroad of the chairman, Sir George Nelson, the chair was taken by Mr. E. C. Holroyde, vice-chairman of the Council. The annual report and accounts were adopted unanimously.

In presenting the report, the chairman said that the Association had had another very busy year and had, he was confident, been of marked assistance to the industry and to the Government. In spite of the many difficulties that had had to be faced, the industry had succeeded in raising its production to a volume exceeding that of 1938, and there was every prospect of being able to meet the new export targets, as well as going a long way towards satisfying the urgent home needs. Further improvement in production was to be expected as the various shortages of labour and materials were overcome; the improvement in the output of iron and steel was a most satisfactory feature. The Association continued its efforts to overcome these shortages of materials. The B.E.A.M.A. census of materials in short supply, together with the direct contact with the basic material producers' associations, had been most helpful.

The electrical industry was a very important factor in the export trade of this country, and would be able to make a valuable contribution towards achieving the desired balance of trade in the dollar and sterling areas. To achieve that and, even more important, to maintain it in the future against increasing foreign competition, the highest degree of production efficiency would be essential. With the import and exchange restrictions imposed in many countries and the development of local manufacture in some of them, Mr. Holroyde felt sure that the selling overseas of a large percentage of the output of the industry would become increasingly difficult and that, in addition to achieving the most efficient production, as regards both costs and quality of products, selling efforts would need to be of the highest order.

As had already been indicated in the chairman's letter to all member firms, the B.E.A.M.A. Council took an active part in the proposals put forward by the Federation of British Industries, of which the B.E.A.M.A. is a member, to the Chancellor of the Exchequer on the subject of prices and profits, and had laid emphasis on the fundamental necessity for a greater quantity of goods being produced each week by the same number of people during the period of economic recovery.

In his address a year ago, the chairman referred to the then pending nationalisation of the electricity supply industry, which had since eventuated, the British Electricity Authority being established with the vesting date April 1, 1948. The B.E.A.M.A. had already had discussions with the chairman and members of the Board of the B.E.A., and very friendly relations had been established. In the interests of both the supply and the manufacturing industries, the continued close consultation between the British Electricity Authority and B.E.A.M.A. was recognised as being essential for the future development of the industry. The Council recorded with appreciation the excellent relations with the personnel of the supply industry in the past and the splendid contributions made by the Electricity Commissioners, the Central Electricity Board, the power companies and the municipalities to the development of the electrical industry. From the conversations with Lord Citrine and the members of his Board, there was reason to anticipate the formation of new committees to continue these joint efforts. Thanks were due to the President, chairman, secretary and all I.M.E.A. members of the Joint Committee for their helpful and happy co-operation for many years past.

In the past it had been suggested that the Council was too representative of the heavy plant side of the industry. The present make-up of the Council was that approximately 50 per cent of its members represented specialised firms and 50 per cent the medium or small firms in the industry. It was the Council's practice to ensure that every section was represented, if necessary, by the co-option of a representative of any section which had not been successful in the ballot.

During the year there had been many conferences with Government Departments on matters of importance. In September last a council committee had been granted an interview by the Minister of Supply, at which discussions on the export plan had helped to clarify the position. The Minister's view that any problems involved would be dealt with in a "common-sense" manner was welcome. The rapidity of the extension of the electrical industry's exports was favourably commented upon by the Minister.

The Association continued to give close attention to all aspects of the export trade, and a representative committee had been set up under the chairmanship of the Export Director, with wide terms of reference. During the year the report of the Government trade mission to China, of which Mr. Buist was a member, had been published, and the chairman recommended members to read it, particularly that portion dealing with the development of the electrical industry. Mr. Buist also paid a visit to Austria at the suggestion of the Board of Trade, with regard to the proposals for extensive electrical development there. The B.E.A.M.A. had also had conferences with the representatives of many other overseas countries on their future needs of electrical equipment.

The chairman announced the result of the ballot electing eight members of the Association to be members of the Council as follows :—Bellis and Morcom, Ltd., The Brush Electrical Engineering Company, Ltd., George Ellison, Ltd., Evershed and Vignoles, Ltd., Ferguson, Pailin, Ltd., The Jackson Electric Stove Company, Ltd., Metropolitan-Vickers Electrical Company, Ltd., The Mirrlees Watson Company, Ltd.

At the subsequent meeting of the new Council the following firms were co-opted members of the Council :—Arc Manufacturing Company, Ltd., Birlec, Ltd., The English Electric Company, Ltd., Johnson and Phillips, Ltd., M.K. Electric, Ltd., Nalder Brothers and Thompson, Ltd., Newton and Wright, Ltd., Bruce Peebles and Co., Ltd., Venner Time Switches, Ltd.

Sir George Nelson and Mr. E. C. Holroyde were unanimously re-elected chairman and vice-chairman respectively for the next session.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1.

B.S.I. YEARBOOK, 1947

THE 1947 edition of the British Standards Institution's Yearbook has just been published. It contains a subject index and a brief synopsis of the 1400 B.S. Specifications now current. These standards have been prepared by representative committees of fifty different industries. The Yearbook includes also lists of members of the B.S.I. General Council, Divisional Councils and Industry Committee, as well as other useful information on the Institution's work. The price of the book is 3s. 6d., including postage.

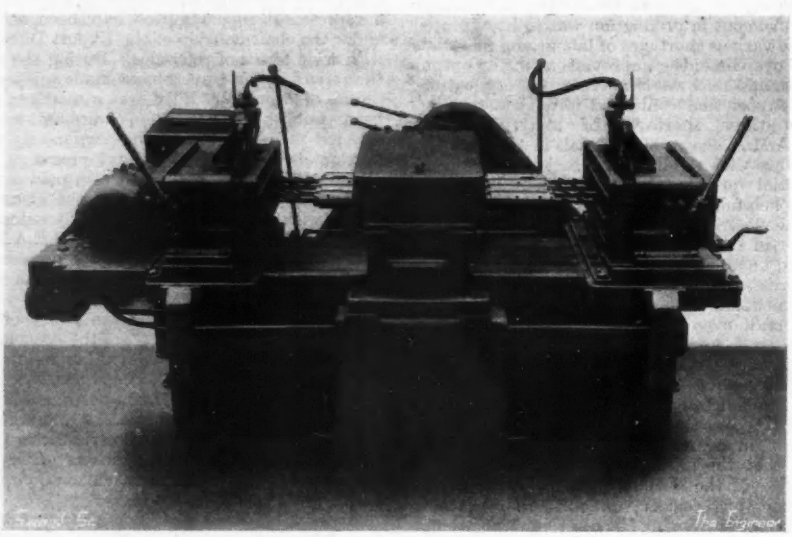
ANNEALED STEEL WIRE FOR SPRINGS

No. 1429 : 1947. This Standard for annealed steel wire for oil-hardened and tempered springs (for general engineering purposes) provides for a range of qualities of plain carbon steel and two types of alloy steels, silicon manganese and chromium vanadium, as specified in B.S. 970, in the form of annealed steel wire for oil-hardened and tempered springs for general engineering purposes. For each type, two grades are specified—grade 1, ground, and grade 2, unground. The section on general clauses includes details of manufacture, details of a test on the rod from which the wire is to be produced, methods of test on the wire and tolerances. For each steel the chemical composition and acceptance tests are specified. Price 2s. each.

A Fishplate Drilling Machine

A NEW horizontal, multi-spindle drilling machine has recently been designed and built by Kitchen and Wade, Ltd., Gibbet Street, Halifax, for drilling fishplates and similar components. This machine, a photograph of which we reproduce, is intended for a high rate of production to a consistent degree of accuracy.

The work-holding jigs of this machine are mounted at each end of a traversing table, and each jig is designed to accommodate two fishplates. Facing each jig is a group of drill spindles, mounted in fixed, centrally disposed heads situated on a bridge over the traversing table. The components in the jig at one end of the machine are drilled, whilst the finished workpieces in the other jig are being removed and replaced by blanks. As



FISHPLATE DRILLING MACHINE

the operator inserts the two undrilled fishplates in a jig they are located by hardened steel rollers formed to conform with the profile of the plates. The components are locked in the jig by a clamping lever at the front.

In the cycle of operations, when a jig has been loaded and locked, the depression of a switch button starts the drill spindles and the table is rapidly traversed to carry the jig towards its drill head. Immediately before drilling actually commences the traversing speed is automatically reduced to the drill feed speed. The sideways movement of the table automatically carries the jig at its opposite end away from its drilling position, and the fishplates in it can then be removed and replaced whilst drilling proceeds at the other station. On completion of one drilling operation the machine is automatically stopped and, on depression of the starter button for the other end, the newly loaded jig is traversed into its working position.

The jigs supplied with this machine are designed to accommodate any type of four-hole fishplates having the holes at the outer ends up to 24in apart. When adapting the jigs to accommodate different sizes of fishplates the only parts it is necessary to change are the subsidiary pilot bush plates and the formed locating rollers. A simple, easily operated ejector in the jigs facilitates and speeds the removal of the components after drilling.

Each of the groups of four spindles in the heads is adjustable for centres between 3½in and 6in. A suitable range of feeds and speeds is available for drilling holes from ⅜in to 1¼in diameter in steel.

The main drive of the machine is taken from a constant-speed 15 h.p. motor at the rear, through multiple-vee belts and a single-lever, change gearbox, directly to the spindle heads. A separate motor for quick traversing purposes is fitted directly on the machine table. The coolant supply for each drill is automatically controlled by the movement of the machine table, and is only effected whilst the actual drilling operation is taking place.

Technical Reports

The Behaviour of Stanchions Bent in Double Curvature: Fifth Interim Report of the FE.1 Committee of the British Welding Research Association. Welding Research, February, 1948. Reprints available on application to B.W.R.A., 29, Park Crescent, London, W.1.—This paper reports part of a major experimental investigation, which was commenced some nine years ago by Professor J. F. Baker at Bristol University under the ægis of the former Welding Research Council. In latter years this investigation has been continued under Professor Baker's direction at the Engineering Laboratory, Cambridge, and now constitutes the experimental programme of the FE.1 Committee on the load-carrying capacity of frame structures.

The object of the investigation is to determine experimentally the true load-carrying capacity of members in rigid frameworks, and subsequently from the data obtained to develop a rational design method. For the successful development of such a design method an understanding of the fundamental behaviour of structural members in the plastic range of the material is necessary in order that the real strength of a rigid structure may be calculated.

Earlier work has been done to provide this information in the case of stanchions bent in single curvature. In this report the problem of double curvature bending is considered.

While the application of the information obtained from these investigations is not restricted to welded structures, it is, nevertheless, of particular significance to this type of construction, since joints possessing a high degree of rigidity may be produced most simply by means of welding.

In the work described, a series of tests was carried out on stanchion lengths of rectangular cross-section, bent in double curvature by end moments of the same sense applied through a system of loaded beams framing into the stanchion on one side. Following the application of the beam loads the stanchions were subjected to additional axial loading until collapse occurred. Various conditions were studied, including equal and unequal loading between the top and bottom beams.

Heat Flow Measurements. By Ricardo and Co. Reports and Memoranda No. 2171: Aeronautical Research Council, Ministry of Supply, H.M. Stationery Office. Price 3s.—This report describes experiments made on a water-cooled engine, using a technique of measuring the temperature gradient along the cylindrical wall by means of a traversing thermo-couple. The best type of thermo-couple for use is described.

The Mobile Locomotive Testing Plant of the London, Midland and Scottish Railway*

By H. I. ANDREWS, Ph.D., M.Sc. (Eng.), A.M.I.Mech.E.†

(*Continued from page 411, April 23rd*)

As the maintenance of constant indicated horsepower represents the basis of all testing of this kind, particular attention is being given to the problem of indicating, and it is proposed to employ a Dobbie-McInnes Farnboro (Royal Aircraft Establishment) type indicator, which, while already suitable for diesel locomotives, is also being developed for use with steam. This form of indicator appears particularly suitable for use in tests under approximately constant conditions, as a composite diagram is obtained during a large number of cycles, so that, by suitable manipulation, a diagram representing the average working of the engine over the period of test can be obtained. The diagram is recorded on a drum revolving with the engine by an electric spark which occurs each time the pressure in the cylinder reaches the same value as a steady balancing pressure of air which is conveyed to the cylinder elements by piping from the dynamometer car. By gradually varying this balancing pressure the complete indicator diagram can be traced out, and by connecting the indicator in turn to different cylinder elements, a diagram for each end of each cylinder may be obtained. The indicator drum will be driven in exact synchronism with the engine by means of two geared Selsyn units designed to reproduce rotation within an accuracy of ±1 deg. In the case of steam locomotives the transmitting Selsyn must be coupled to the driving axle through an Oldham coupling mechanism to allow for the relative movement of the axle. Diagrams traced on a revolving drum are actually on a crank angle base, but can, however, be readily converted into the normal form, or alternatively the indicated horsepower may be determined directly from the diagram by the method described in Appendix I.

In the compartment immediately behind the indicator compartment, provision has been made for the installation of equipment for analysis of the flue gases similar to that already installed in the L.M.S. gas-analysis car. This equipment has been described by Lewis-Dale (1936) and by Binns and Bairstow (1936).

All instruments installed on the dynamometer car are arranged to work from a 230-V, 50-cycle a.c. supply so that they may be adjusted and calibrated in the laboratory, and it has therefore been necessary to arrange a similar supply, controlled in voltage and frequency to ±1 per cent, on the dynamometer car. An ample supply of 200-V d.c. is available from the braking units, but as some independent source of power is essential when the car is not attached to a unit, a 48-V carriage lighting generator is driven from one of the axles, charging a battery through a carbon-pile regulator. This battery supplies the lighting of the coach, and by earthing its centre point a 24-V potential is obtained for the recording table. The 230-V a.c. supply must therefore be obtained from either the 200-V or the 48-V supplies, and arrangement must be made for the 48-V battery to be charged from the 200-V supply. This is done by a motor generator set suspended under the car. It comprises a 2·5-kVA, 230-V generator with separate exciter, driven by either a 7 h.p., 200-V d.c. motor, or a 3 h.p., 48-V d.c. motor, which latter machine functions as a generator charging the battery when the 200-V d.c. motor is in use. The speed of the set, and the a.c. voltage generated, are controlled by electronic regulators which are included with the necessary switchgear and the 48-V regulator in the auxiliary control panel in the recording and control compartment, from which the motor generator set may be started, and the a.c. supply controlled, whichever source of power is available.

The Mobile Testing Units.—Except for the

* Institution of Mechanical Engineers, Friday, April 16, 1948. Abridged.

† Engineering research staff, London, Midland and Scottish Railway.

bogies and the braking resistors, the three mobile testing units are identical, their general arrangement being as shown in Fig. 6. They are, in effect, powerful motor coaches equipped for rheostatic braking only, and are carried on two four-wheeled bogies having a generator driven from each axle. In view of the weight of these vehicles, and the high speeds for which they are required, special attention was given in design to their suspension and riding qualities and to the avoidance of undue wear of the track. The bogies all have a wheel base of 10ft, and while the usual nose-suspended arrangement is employed for the generators of the low-speed unit, the generators of units Nos. 2 and 3 are fully supported by the bogie frames, being coupled to the axle by flexible drives. The power generated in opposing the draw-bar pull of the locomotive is dissipated by banks of metallic resistors heating two columns of air drawn by fans from beneath the coach and expelled vertically through the roof. The auxiliary power required for these fans, for the blowing and excitation of the generators and for other purposes, is provided by a 100 h.p. diesel generator set, a battery for standby and emergency use being housed in a separate compartment. All electrical controls, other than the master controls in the dynamometer car, are centralised in the electrician's compartment at one end of the car, the other end being fitted as a guard's compartment. Each unit is so arranged that it may be operated either independently or in any combination with the dynamometer car and the other units.

The underframe (which supports the diesel generator set, the main resistors, the battery and the blowers) is, of course, much heavier than that of a standard motor coach, but it is of similar construction, being built up of channel sections by riveting. The coachwork also corresponds to L.M.S. standard practice as closely as possible, being a wooden framework with sheet steel exterior panelling. The openings in the roof above the main resistors are closed when not in use by sliding covers operated from within. Standard braking equipment is fitted, including a guard's hand brake. The suspension, in the design of which Mr. T. H. Sanders was consulted, includes swing-link bolsters with four nests of helical springs, each nest having an outer coil of circular section and an inner coil of rectangular section giving a static deflection of 2½in under load. The side bearing springs, which are of laminated form with reverse camber, give a static deflection of 2¾in and are supported by twin-coil auxiliaries giving an additional deflection of 1¾in. The resonance frequency of the bolster springs is therefore 129 cycles per minute, and that of the side bearing system is 95 cycles per minute. With this arrangement resonance of the side bearing system is unlikely to occur, but should a section of bad track be encountered having 60ft rails, the critical speed for resonance of the bolster springs would be 88 m.p.h.

The main generators of the three units are electrically identical and are continuously rated at 375 h.p.; they differ only in gear ratio and in the method of suspension. Since each is connected directly to its own resistance bank, no question of paralleling arises, and they are therefore fitted with slip rings and generate three-phase alternating current at 0–700V and at a frequency between 0 and 70 cycles per second, dependent on the speed. Apart from the slip rings, the generators are constructed on the lines of d.c. traction motors. The field system has four poles wound for separate excitation, no interpoles or compensating windings being needed, and the armature winding is arranged like a normal lap winding of a d.c. machine. Each generator is force ventilated by its own motor-driven blower, so that its cooling is independent of the speed of the train.

The loading resistors have each a continuous rating of 300kW corresponding to that of the associated generators. Each resistor is composed of a bank of twelve resistance boxes, the resistance element of each box being in the form of a single looped strip of low-silicon steel. The resistance bank is carried in a steel framework and enclosed in steel sheeting, open at the top and bottom, forming a "chimney" up which air is forced by a motor-driven fan at a mean velocity of about 870ft per minute. The narrow steel strip is naturally a very efficient means of heat transfer, and, when under full load, reaches a temperature of 600 deg. Fah. after about twenty minutes, while the temperature of the air discharged rises to about 350 deg. Fah. Each resistor has its own switchboard, with an isolating switch and fuses, hand switches as necessary for adjusting the resistances to the appropriate speed ranges for the various combinations of units, and remotely controlled contactors for altering the resistance values at low speed. The arrangements of these switches differ on the resistors of the three units, but in every case except that of the high-speed unit when working at very low speeds, the whole of the resistance elements are utilised for heat dissipation.

The auxiliary generator set, comprises a 100 h.p. A.E.C. diesel engine, running at 1650 r.p.m.; a 45-kW d.c. generator, providing auxiliary power at 200V; a 12½-kW d.c. generator, providing the excitation for the main generators at 0–150V; and a 2-kW, three-phase alternator, giving 230-V, 55-cycle a.c. for operating the controls. A thrustor-operated mechanical clutch between the engine and the first generator allows the engine to be separated in case of failure, when the 200-V machine is motored from the battery, driving the remaining two machines. The engine is provided with a separate starting equipment working at 24V, a small instrument panel, a 50-gallon cooling water tank with 25 gallons reserve in the roof, a radiator built into the side of the coach with a motor-driven fan and two tanks containing 200 gallons fuel oil suspended beneath the coach. In normal working this generating set supplies all the various auxiliaries, the heating and lighting of the coach, a steady charge to the battery and in addition some 30kW can be supplied to the dynamometer car if required. The battery, which consists of 100 lead-acid cells of 120A-hr capacity carried in racks in its separate ventilated compartment, represents an emergency standby for the diesel engine, and also provides lighting and heating when the engine is not in use.

Apart from the extended wheel base, the design of the bogies of the low-speed unit is very similar to that of the Euston-Watford motor coaches, and it was found possible to incorporate many of their standard parts. The bogie frames are of riveted construction, though certain of the individual members are fabricated. The nose of each generator is held between four rubber pads in a box bracketed to the central cross member, the suspension bearings resting upon the axle in the normal manner. The gears and pinions are of forged steel, flame hardened, giving a 16–91 gear ratio, and are grease lubricated, being enclosed in fabricated steel gearcases bracketed from the generator frame. For convenience, the bogie springs have been made interchangeable with those of the higher-speed bogies; nevertheless, this unit rides very well up to its maximum speed of 50 m.p.h.

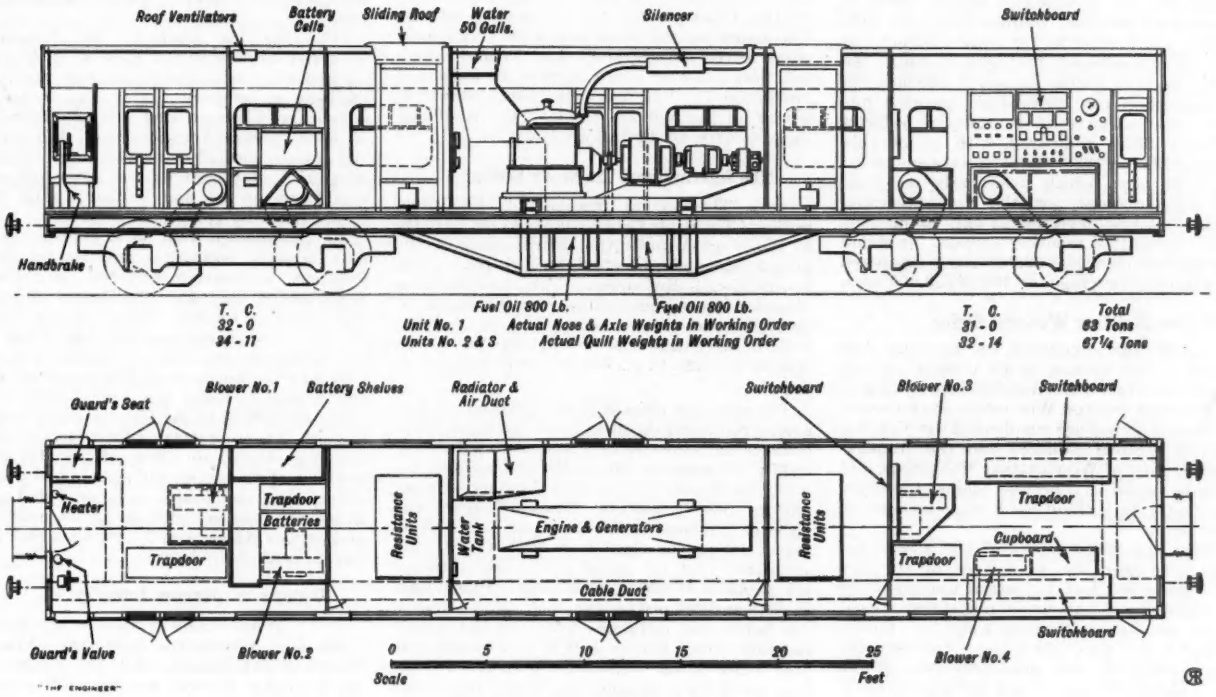


FIG. 6—*Arrangement of Mobile Testing Unit*

The underframe (which supports the diesel generator set, the main resistors, the battery and the blowers) is, of course, much heavier than that of a standard motor coach, but it is of similar construction, being built up of channel sections by riveting. The coachwork also corresponds to L.M.S. standard practice as closely as possible, being a wooden framework with sheet steel exterior panelling. The openings in the roof above the main resistors are closed when not in use by sliding covers operated from within. Standard braking equipment is fitted, including a guard's hand brake. The suspension, in the design of which Mr. T. H. Sanders was consulted, includes swing-link bolsters with four nests of helical springs, each nest having an outer coil of circular section and an inner coil of rectangular section giving a static deflection of 2½in under load. The side bearing springs, which are of laminated form

(*To be continued*)

Industrial and Labour Notes

British Overseas Trade

The value of United Kingdom goods exported during March was £120,958,075, a higher figure than that recorded in any month since July, 1920. Imports in March, however, were at the high level of £178,194,829, which was greater than in any month apart from July, 1947, and January, 1920. Re-exports in March were valued at £6,130,301, and the total adverse trade balance was therefore £51,106,453.

The Easter holiday reduced the number of working days in March to twenty-five, but even so, the volume of exports is estimated to have been 129 per cent of 1938, compared with 121 per cent in February and 128 per cent in January. Machinery exports again took a leading place in the month's figures, totalling in volume 69,570 tons, compared with the 1938 monthly average of 38,272 tons. Exports of vehicles also continued at a high rate during the month, and in value exceeded £20,000,000. The number of new motor-cars exported was 16,343, and exports of commercial vehicles numbered 2608, compared with a monthly average of 381 in 1938. Coal exports amounted to 426,126 tons, which was nearly one-third above the average for the two preceding months, but was nevertheless only about one-seventh of the 1938 monthly average. Iron and steel exports totalled 162,931 tons, compared with a monthly average in 1938 of 159,656 tons.

Vehicle Building Workers' Strike

It was announced on Saturday last that the 20,000 workers in the vehicle building industry, who had been on strike since April 2nd, would resume work on Wednesday of this week. The men concerned are members of the National Union of Vehicle Builders and the Amalgamated Society of Woodcutting Machinists, and the strike began as a protest against the delay in dealing with a claim for a wage increase of 3d. an hour.

During the three weeks of the strike discussions between the executives of the two unions and the Chief Industrial Commissioner of the Ministry of Labour did not at first appear to lead to any satisfactory solution. Subsequently there were discussions between the union executives and representatives of the T.U.C. General Council, and further consultation with the Ministry of Labour. After a joint meeting of the executives of the two unions at the end of last week it was recommended that work should be resumed "in the national interest and in the interests of the trade union movement within T.U.C. policy." Prior to the strike it had been arranged that the claim should come before the National Arbitration Tribunal on April 28th, but it is reported that the joint meeting of union executives last week expressed the view that the special circumstances of the case made a settlement by negotiation particularly desirable.

The National Foundry College

The first post-war session of the National Foundry College is now in progress, and eighteen students from the United Kingdom and overseas are taking part in it. For the present, the College is housed in the Wolverhampton and Staffordshire Joint Technical College. The next session will open on September 27th and will continue until the end of July, 1949. Forms of application for admission and also the prospectus of the course can be obtained from the Head of the College, Mr. J. Bamford, at the Technical College, Wulfruna Street, Wolverhampton.

Committee on Industrial Productivity

The Lord President of the Council, Mr. Herbert Morrison, was questioned in Parliament last week as to the progress being made by the Committee on Industrial Productivity and as to when its first reports might be expected.

Mr. Morrison said in his reply that the Committee held its first meeting on February 4th last and, in all, the Committee and its four panels had met twenty-four times this year. A wide range of possibilities for increasing industrial productivity was being examined, and several new research projects had already been set in hand by the Committee. The Lord President stated that he was unwilling to direct the Committee's energies into preparing a formal written report at so early a stage, but he gave an assurance that the machinery was proving effective.

It may be recalled that the setting up of the Committee on Industrial Productivity was announced on December 18th last. Its Chairman is Sir Henry Tizard, and the purpose of the Committee is "to advise the Lord President of the Council and the Chancellor of the Exchequer on the form and scale of research effort in the natural and social sciences which will best assist an early increase in industrial productivity." It has also been asked to advise on the manner in which the results of such research can best be applied.

The International Tin Study Group

The second meeting of the International Tin Study Group has been held recently in Washington under the chairmanship of Mr. Donald Kennedy, Chief of the U.S. Division of International Resources. The meeting was attended by seventy-three representatives of and observers from member nations, and the British delegation was headed by Mr. V. P. Harries and Mr. C. A. James, of the Ministry of Supply.

The principal objects of the meeting were to review the world tin situation in the light of the changes since the Group's first meeting in April, 1947; to examine the statistical position for world tin production, consumption and stocks; and to receive reports of operations of the Group's management committee and secretariat during the fiscal year 1947–48. It was estimated that the world production of mined tin would be 150,000 tons in 1948, 170,000 tons in 1949 and 200,000 tons in 1950. These figures are below the estimates given at last year's meeting of the Group, and it was stated that they reflected the difficulties in the rehabilitation of the Far Eastern tin mines and some reduction in the tonnage estimated from other sources. The potential industrial consumption of tin was estimated as 190,000 tons for 1948, 1949 and 1950. The Group decided to recommend to member-Governments the setting up of a working party to examine the practicability of framing an inter-governmental agreement on tin which would conform to the general spirit and principles of the Charter of the International Trade Organisation.

Co-operation Between Workers

The Association of Supervisory Staffs, Executives and Technicians and the Amalgamated Engineering Union have recently issued a joint statement stressing the need for the "closest co-operation between workers, whatever their occupation or status."

Pointing out that the serious economic crisis facing the people of Britain can be overcome only by the joint efforts of all progressive people, the statement says that the solution of production problems in the engineering industry demands the widest possible application and development of joint consultation. This, it is suggested, calls for the closest working alliance of the organised workers and the organised supervisory, technical and managerial staffs. There is, the statement continues, neither room nor time for hostility between worker and worker, "whatever the grade or title may be." Team work, particularly co-operation on the job, is the most effective way of realising a policy of a planned engineering industry.

The statement adds that a matter of special concern to the two unions is the giving of the greatest possible encouragement to all workers to undertake supervisory and managerial positions. There must be, it is urged, no hostility towards workers undertaking such responsibility, in the same way as none is shown to those from the workshops taking part in joint consultation machinery. The road to such supervisory and managerial positions, the statement ends, must be completely open to all on the basis of merit and merit alone.

The Tees-side Chamber of Commerce

At the annual meeting of the Tees-side Chamber of Commerce, which was held recently in Darlington, Mr. T. H. Summerson was elected President. He is chairman and joint managing director of Thomas Summerson and Sons, Ltd., and of Summerson's Foundries, Ltd.

Following his election, Mr. Summerson delivered his presidential address, in the course of which he said that there was no lack of idealism in industry to-day and it had the advantage of being rooted on a solid foundation of hard, practical experience. Industry by and large cordially disliked and suspected many of to-day's trends, but direct opposition would cut no ice and industry must defeat those trends by going one better.

Mr. Summerson went on to express the view that industry, seeing the flaws in the present tendency to worship universal centralisation, must design its own progressive alternative and make it known. Some of the features of that alternative were, he suggested, first-rate management, real enterprise, and unrestricted scope for all with the necessary ability and willing to make the needed effort to rise from the bottom to the top. Another essential feature, Mr. Summerson added, was an understanding which, in place of the hit-or-miss methods of to-day, would enable the proceeds of increased real wealth to be allocated among those who had contributed to its creation in proportions which would give all a real incentive to greater production.

Reports on German Industry

The German Division of the Board of Trade is continuing the organisation known as Technical Information and Documents Unit, 40, Cadogan Square, London, W.1, for the purpose of disseminating the results of technical investigations undertaken in Germany and also giving technical advice on German wartime industrial processes. Lists of reports of special interest to engineers are published regularly in our columns, and in addition to circulating these reports, the Unit has available for consultation an extensive library of original German documents, treatise and research reports.

At present the Technical Information and Documents Unit is publishing a series entitled "B.I.O.S. Overall Reports." These reports, it is stated, are surveys of individual industries and attempt to show what—if anything—Britain has to learn from Germany in the technical and industrial fields. British experts have examined carefully all the German information which has been brought over to this country and have compared it critically with the latest British practice in their own particular industries. The critical summaries of these experts have been embodied in the "Overall Reports" now being made available.

The Iron and Steel Board

The Minister of Supply has stated in a Parliamentary reply this week that the Iron and Steel Board's responsibilities are, broadly, to consider plans for the development and modernisation of the iron and steel industry, including foundries. It is also required to exercise general supervision over production; to administer the current controls in production, distribution and imports, and to advise on general price policy and on the fixing of prices for controlled products.

French Engineering News

(From our French Correspondent)

The Aciéries de Longwy has started a third blast furnace in the Thionville plant, bringing the number of blast furnaces used by this company to six. A seventh will probably be lit at Mont-Saint-Martin towards the middle of the year.

* * *

The Mixed Transport Commission has reported favourably on a plan for the future of Paris transport. The inquiry related to a big programme of works, planned to be completed in 1955.

The new works will include electrification of the Vincennes line, extension of line No. 13 to St. Denis, an increase of 600 buses (to make a total of 2500), and replacement of old vehicles, an additional 36km of trolleybus lines, improvements in central repair shops, lengthening of "Metro" stations, and, finally, the improvement of entrances to the Metropolitan railway at various railway main line termini.

* * *

Increased steel production has enabled allocations for the second quarter to many industries to be increased. For March, steel production was 620,000 tons, as against 564,000 tons in February, and exceeded the 1947 monthly average (479,000 tons) and that of 1938 (518,000 tons). Sheet steel production in March was 450,000 tons, as against the 1947 average of 336,000 tons, and Martin steel production was 217,000 tons, as against 160,000 tons.

* * *

Cement production increased from 360,000 tons in January to 370,000 tons in February, and March figures are expected to show a further increase. With the increased coal resources, larger allocations are expected to be made for construction materials, particularly cement, and it is thought that 500,000 tons a month will be produced by the summer, when sale restrictions will be lifted. It is likely, however, that transport difficulties may hold up deliveries because foreign currency for the purchase of sacks is not available. The possibility of using wooden containers suitable for transport by road, rail or sea is being considered.

* * *

The National Statistical Institute of Economic Studies has published indices relating to French industrial production in January, 1948, taking 100 as a base for 1938. The following are some of the more interesting figures :—

	1947				1948
	Jan.	May	Oct.	Dec.	Jan.
Electricity	132	127	133	130	145
Gas	147	144	153	153	160
Oil, motor spirit ...	51	76	92	71	74
Coal	102	101	101	76	108
Metal mining ...	61	65	65	57	71
Steel	91	100	106	80	104
Chemical industry	102	125	109	97	123
Rubber	110	121	128	115	152

Despite general indications of improvement in production, it is pointed out that 1938 production was itself very poor and much lower than that of 1929. There are also still industries which have not reached 1938 levels, and some of these are among the most essential, such as production of petrol, metal mining and building materials. Also, in 1938 considerable stocks existed which are not available to-day.

* * *

Work is shortly to begin on the construction of the Toulouse-Bordeaux pipe line, which will supply natural gas to a large part of the south-west of France. Since 1942, a pipe line has supplied gas to Toulouse, and a network of 520km total length now feeds Tarbes, Lannemezan, Pamiers and Saint-Girons. Saint-Gaudens natural gas is used for many purposes, including lighting, heating, motor transport and chemical manufacture. It also produces important by-products, such as liquid butane. One cubic metre of gas replaces 2kg of coal used in steam boilers and industrial ovens, or 2kg of coke in the manufacture of hydrogen, or 1·3 litres of petrol when used in a car.

Notes and Memoranda

Rail and Road

NEW TURNTABLE AT CREWE.—A new turntable of 70ft diameter has recently been installed at the Crewe South Motive Power Depot of the London, Midland Region of British Railways, in place of a 60ft turntable. It enables the largest class of 4–6–2 express passenger engines to be turned on the south shed, thus avoiding the occupation of the running lines hitherto involved in turning them on an adjacent triangle.

JOINTS IN CONCRETE PAVEMENTS.—The Engineering Experiment Station, University of Illinois, has lately issued a bulletin entitled "Experience in Illinois with Joints in Concrete Pavements," by J. S. Crandell, V. L. Glover, W. C. Huntington, J. D. Lindsay, F. E. Richart and C. C. Wiley. It reports investigations conducted by a special committee composed of members of the staffs of the Departments of Civil Engineering and Theoretical and Applied Mechanics of the College of Engineering and the Division of Highways, State of Illinois. These investigations included laboratory tests, field investigations and observations and measurements made on the Armington experimental road, and the final chapter of the bulletin presents many general and specific conclusions relating to various types of joints, caps, and fillers and load transmission devices.

INNER LONDON TRAFFIC SURVEY.—To facilitate the investigation of certain long-term proposals for the relief of traffic congestion in London, the Minister of Transport invites the co-operation of owners and drivers in the taking of a short-period survey of the distribution of traffic converging on Inner London. The survey will be made by the Metropolitan Police with the assistance of personnel provided by the Royal Automobile Club and the Automobile Association, and will be carried out at seven key points on roads approaching Inner London. To obtain a true reflection of the normal flow of traffic the location of the points and the days chosen will not be announced, but the points will be indicated by warning notices to drivers. Each investigation will last only two hours, from 8 a.m. to 10 a.m., and the information which it is hoped to obtain affects only commercial vehicles and private cars proceeding to Inner London. Drivers of commercial vehicles and private cars will be asked by the police to pause and to give their next point of call, with the name of the road or locality. No identification of the vehicle will be taken and no names and addresses, nor questions asked as to the use of petrol or of the vehicle. The Ministry of Transport emphasises that the information is wanted only for traffic purposes.

Air and Water

SWEDISH TIMBER FLOATING OPERATIONS.—The result of last year's timber floating operations in Sweden is reported to have been very poor, on account of the low level of all waterways. *The Anglo-Swedish Review* says that at the end of the season no less than 33,600,000 logs—or 93,800,000 cubic feet of timber—were still left in the waterways. This is a quantity equal to about 19 per cent of the total volume of logs which had been reported ready for floating.

THE ORVILLE WRIGHT AEROPLANE.—It is stated that plans are now being made by the Science Museum, South Kensington, and the executors of the estate of Orville Wright in Dayton, Ohio, U.S.A., for the early return to the United States of the Kitty Hawk aeroplane of 1903. This historic Wright aeroplane, the first power-driven aircraft to accomplish human flight, is to be deposited in the United States National Museum in Washington.

JET ENGINE PRODUCTION IN THE ARGENTINE.—The Argentine Government has concluded a licence agreement with the Rolls-Royce Company for the manufacture of Rolls-Royce "Derwent" gas-turbine engines in Argentina. The agreement was negotiated on behalf of the Argentine Government by the Instituto Aerotecnico Secretaria de Aeronautica, Cordoba, and was ratified by President Peron. The engines will be manufactured at the Government factory in Cordoba.

GLASGOW CORPORATION WATER DEPARTMENT.—The Glasgow Corporation has placed a contract for pipe laying in connection with the East Main-Milngavie outlet works. The main connection to the 36in diameter East Main is to be made from the existing straining well at Craigmaddie reservoir. From this well a new 48in diameter pipe connection will be taken off at a depth of 25ft below top water level of the reservoir and laid in tunnel to a 48in diameter control valve situated in a new valve shaft 32ft deep and 12ft internal diameter. From this shaft the 48in diameter pipe will be reduced to 42in diameter and laid in tunnel a distance of 67 yards to a new reinforced concrete underground valve chamber. Here the main will divide into two 36in diameter pipes, one for future use being blanked off for the present and the other being laid for a distance of 135 lineal yards to join up with Glasgow's new 36in diameter East Main. The contract represents a further instalment in a comprehensive scheme of new works for the Milngavie reservoirs to be carried out in due course in connection with a proposed new West Main for the city.

MOORABBIN AIRPORT, AUSTRALIA.—It is reported that Moorabbin, Melbourne's second official airport, will be ready to take its first aircraft in July, when it is hoped to have a 3000ft grass runway in operation. The airport is being constructed by the Australian Department of Civil Aviation to relieve the pressure of traffic at Essendon. All light aircraft not possessing two-way radio communication, operating in Victoria, will be based at Moorabbin. The land at present acquired will permit expansion large enough for Moorabbin to accommodate any aircraft with an all-up weight up to 90,000 lb.

Miscellanea

NORTH-EAST COAST INSTITUTION.—Mr. Mungo Campbell has been elected President of the North-East Coast Institution of Engineers and Shipbuilders. To fill vacancies on the Council, the following have been elected:—Mr. R. A. Bartram, Mr. T. W. F. Brown, Mr. J. Bulman, Mr. P. L. Jones, Mr. J. B. Kerr, Mr. W. Muckle, Mr. A. Pickworth and Mr. J. W. Elliot. Mr. W. H. Pilmour has been elected Honorary Treasurer.

INSTITUTION OF ELECTRICAL ENGINEERS.—The annual general meeting of corporate members and associates of the Institution of Electrical Engineers will be held on May 13th at 5.30 p.m., in the Institution Building, Savoy Place, Victoria Embankment, W.C.2. Following the meeting, at approximately 6.45 p.m., the Gaumont-British film "Atomic Physics" is to be shown. Admission to the showing of the film will be by ticket only, which can be obtained by members on application to the Secretary.

CONFERENCE ON MECHANICAL WEAR.—A summer conference on mechanical wear, sponsored by the Massachusetts Institute of Technology, the American Society of Mechanical Engineers, the General Motors Corporation and the Chrysler Corporation is to be held in Cambridge, Massachusetts, on June 14th, 15th and 16th. The conference will be devoted to a consideration of all aspects of wear between solid surfaces—its causes, symptoms and cures. Full particulars may be obtained from Professor J. T. Burwell, Mechanical Engineering Department, Massachusetts Institute of Technology, Cambridge, Mass., U.S.A.

HOSPITAL HEATING AND VENTILATION.—The Southern Region of the Institution of Hospital Engineers and the Hampshire Fuel Efficiency Committee are arranging a one-day conference on "The Heating, Hot Water and Ventilating Requirements of a Modern Hospital," to be held at the Civic Centre, Southampton, on Thursday, May 27th. The morning session will begin at 10.30 a.m., when a representative of the medical profession will present the medical point of view, and a consulting engineer will give a paper. The discussion at the afternoon session will be opened by a heating engineer and by the chief fuel engineer of the Ministry of Fuel and Power. Full particulars of the conference can be obtained from Mr. E. C. Rogers, Quay House, Broad Street, Portsmouth.

THE INSTITUTE OF PETROLEUM.—The inaugural meeting of the London Branch of the Institute of Petroleum was held in London recently under the chairmanship of Mr. H. C. Tett. Mr. A. J. Goodfellow, as chairman of the Organising Committee, said that the branch was intended to provide an opportunity for those interested in the less technical aspects of petroleum to meet, to hear papers and discuss matters of interest in an atmosphere divorced from formality. Visits would be made to installations and works, and informal social gatherings, it was hoped, would add to the value of membership of the new branch. People of all ages are eligible for membership. Forms of application are available from Mr. N. E. F. Hitchcock, c/o C. C. Wakefield and Co., Ltd., Research Department, Hayes, Middlesex. The meeting ended with a lecture by Mr. J. A. Oriel, C.B.E., M.C., a Vice-President of the Institute, entitled "Petroleum in the Modern World."

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Chemical Engineering Group

Tuesday, May 4th.—Geological Society, Burlington House, Piccadilly, W.1. "Modern Propellants Employed in British Ordnance," J. N. Pring. 5.30 p.m.

Chemical Society

Monday, May 3rd.—The University, Leeds. "The Valency of Metals and the Structure of Intermetallic Compounds," L. C. Pauling. 6.30 p.m.

Thursday, May 6th.—Royal Institution, Albemarle Street, W.1. "The Molecular Orbital Theory of Valency," Sir John Lennard-Jones. 7.30 p.m.

Farmers' Club

Monday, May 3rd.—Royal Empire Society, Craven Street, W.C.2. "The Lucas Report," Lord Teviot, 2.30 p.m.

Illuminating Engineering Society

To-day, April 30th.—BIRMINGHAM CENTRE: Imperial Hotel, Temple Street, Birmingham. "Lighting for Effect," T. O. Freeth. 7 p.m.

Incorporated Plant Engineers

Wednesday, May 5th.—Royal Society of Arts, John Adam Street, Adelphi, W.C.2. "Oxy-Acetylene Welding," G. Brown. 7 p.m.

Friday, May 7th.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham. Short talks by four members and discussion about the exhibits at the British Industries Fair. 7.30 p.m.

Institute of Marine Engineers

Tuesday, May 11th.—85, The Minories, E.C.3. "Some Aspects of the Manufacture of Large Seamless-Steel Tubes and Hollow Forgings," J. W. R. Naden. 5.30 p.m.

Institute of Petroleum

To-day, April 30th.—Royal Society of Arts, John Adam Street, Adelphi, W.C.2. "The U.K. Petroleum Industry in War," Sir Andrew Agnew. 5.30 p.m.

Institution of Civil Engineers

Tuesday, May 4th.—Great George Street, S.W.1. "Problems in the Selection of Sites for Civil Airports and Military Air Stations," W. J. Cozens. 5.30 p.m.

Thursday, May 6th.—NORTH-WESTERN ASSOCIATION: Engineers' Club, Albert Square, Manchester. Annual general meeting. "Swedish Bridge Construction and the Sandö Bridge," Sven Klingberg. 6.30 p.m.

Institution of Electrical Engineers

Monday, May 3rd.—SOUTH MIDLAND CENTRE: James Watt Memorial Institute, Great Charles Street, Birmingham. "The Nervous System as an Electrical Instrument," B. H. C. Matthews. 5.30 p.m.

Tuesday, May 4th.—NORTH MIDLAND CENTRE: Corporation Electricity Department, Whitehall Road, Leeds. Annual general meeting. 6.30 p.m.

Thursday, May 6th.—INSTALLATIONS SECTION: Savoy Place, Victoria Embankment, W.C.2. Short papers by younger members. 5.30 p.m.

Friday, May 7th.—MEASUREMENTS SECTION: Savoy Place, Victoria Embankment, W.C.2. Discussion on "The Application of Instruments to Power Station Operation." 5.30 p.m.

Institution of Engineering Draughtsmen and Designers

Friday, May 7th.—Royal Society of Arts, John Adam Street, Adelphi, W.C.2. "Timber," W. Ivey; and "Aluminium Alloys," R. R. Osborne. 7 p.m.

Institution of Mechanical Engineers

To-day, April 30th.—Storey's Gate, St. James's Park, S.W.1. Informal meeting. Film on "Atomic Physics." 5.30 p.m.

Institution of Post Office Electrical Engineers

Monday, May 3rd.—Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. "The Crossbar Switch and its Use in the Swedish Telephone System" J. A. Lawrence. 5 p.m.

Institution of Production Engineers

Saturday, May 1st.—HALIFAX GRADUATE SECTION: White Swan Hotel, Halifax. Luncheon and annual general meeting, followed by "The Manufacture of Gas Turbines," L. H. Leedham. 2.30 p.m.

Wednesday, May 5th.—NOTTINGHAM SECTION: Victoria Station Hotel, Milton Street, Nottingham. "Metal Finishing." 7 p.m.

Thursday, May 6th.—SOUTH WALES AND MONMOUTHSHIRE SECTION: Visit to the Bristol Aeroplane Company, leaving Cardiff at 10.30 a.m.

Institution of Structural Engineers

Thursday, May 6th.—WALES AND MONMOUTHSHIRE BRANCH: South Wales Institute of Engineers, Park Place, Cardiff. Annual general meeting. 6.30 p.m.

Junior Institution of Engineers

To-day, April 30th.—39, Victoria Street, S.W.1. Informal meeting. "The Hallade Track Recorder," W. M. Bond. 6.30 p.m.—NORTH-WESTERN SECTION: Manchester Geographical Society, 16, St. Mary's Parsonage, Manchester. Presidential Address, "'Coronation-Scot,'—A Railway Development," R. A. Riddles. 7 p.m.

Wednesday, May 5th.—MIDLAND SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham. "The Development of a Domestic Gas Appliances," H. S. Walter. 6.30 p.m.

Friday, May 7th.—39, Victoria Street, S.W.1. "Technical Evidence: Some Reminiscences," W. A. Tookey. 6.30 p.m.

Royal Institution of Great Britain

To-day, April 30th.—21, Albemarle Street, W.1. "The Age of the Universe," Sir Harold Spencer Jones. 9 p.m.

Friday, May 7th.—21, Albemarle Street, W.1. "Life in Russia To-day," Edward Crankshaw. 9 p.m.

Society of Engineers

Monday, May 3rd.—Geological Society, Burlington House, Piccadilly, W.1. "The Development of the Jet Propulsion Engine," W. T. Winter. 5.30 p.m.

Women's Engineering Society

Friday, May 7th.—35, Grosvenor Place, S.W.1. "Starting an Engineering Business," Miss V. Holmes. 6.30 p.m.

Personal and Business

MR. BASIL SANDERSON has joined the board of the Ford Motor Company, Ltd.

MR. F. J. ERROLL has been appointed a director of Richard Johnson and Nephew, Ltd.

MULLARD WIRELESS SERVICE COMPANY, LTD., will in future be known as Mullard Electronic Products, Ltd.

MR. T. A. SANGSTER has been appointed sales manager of Riley (Coventry), Ltd., in succession to the late Mr. V. Leverett.

ELTEE EQUIPMENTS, LTD., London Road, Staines, has been appointed sole distributor in the British Isles for Le Tourneau products.

GROUP CAPTAIN P. MCDIARMID has been appointed technical representative in the Government Contracts Division of the Plessey Company, Ltd.

MR. P. A. H. ELLIOT is relinquishing the position of Director of the Combustion Appliance Makers' Association, which he has held for the past three years.

J. H. FENNER AND CO., LTD., has opened a branch office at 86, Bridge Street, Sheffield, 1 (Telephone, Sheffield 27774). Mr. G. K. Varley is the branch manager.

MUSGRAVE AND CO., LTD., Belfast, has opened a branch office at 89A, Clayton Street, Newcastle-upon-Tyne. Mr. W. J. Adams has been appointed manager.

HADFIELDS, LTD., announces the retirement of Mr. W. S. Spicer, chief buyer and stores superintendent. He has been a local director since 1946, and has been in the company's service for forty-seven years.

THE BRITISH IRON AND STEEL RESEARCH ASSOCIATION states that Mr. R. H. Myers has retired, on account of ill-health, from the position of head of the steelmaking division. Dr. A. H. Leckie has been appointed to succeed him.

THE COMBUSTION APPLIANCE MAKERS' ASSOCIATION announces the resignation of Mr. P. A. H. Elliott from the post of director. The Association's new address is 24, Tottenham Court Road, London, W.1 (telephone, Museum 5543).

THE FEDERATION OF BRITISH INDUSTRIES states that Major C. R. Dibben is relinquishing the office of Midland Regional Secretary in order to devote more time to other industrial interests. Mr. Ion Earle is to succeed him on September 1st.

TUBE INVESTMENTS, LTD., announces the following appointments in its light alloys division: Mr. W. H. Bowman, technical director of Reynolds Light Alloys, Ltd., Reynolds Rolling Mills, Ltd., and the South Wales Aluminium Company, Ltd., and Mr. E. G. Snelus, sales manager of Reynolds Light Alloys, Ltd., and Reynolds Rolling Mills, Ltd.

THE ASSOCIATED EQUIPMENT COMPANY, LTD., announces that its overseas sales department has been transferred from Southall to 7, Chesterfield Gardens, Curzon Street, London, W.1 (telephone, Regent 4318; telegrams, "Vangastow, Phone, London"). Sales matters relating to the Metropolitan, eastern and south-eastern areas will also be dealt with at this address.

Contracts

G. AND J. WEIR, LTD., Cathcart, Glasgow, has received an order from the Netherlands Government worth £500,000, payable in U.S. dollars, for plants to distil fresh water from sea water, which are to be installed in the Dutch West Indies. Practically all the work on this contract will be carried out in the West of Scotland. The boilers for the plants will be made at Renfrew by Babcock and Wilcox, Ltd., and the structural engineering work by A. and J. Main and Co., Ltd., Possilpark, under the supervision of G. and J. Weir, Ltd., who will make the evaporating and distilling plants.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committee on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of report	Title	Post free s.	d.
F.I.A.T.:			
1014	Miscellaneous Pharmaceuticals and Pharmaceutical Intermediates Manufactured at I.G. Farbenindustrie A.G., Elberfeld: Report in German	7	3
1038	Bearing Jewels of Hardened Synthetic Spinel	4	2
1040	Methods of Standardisation of Vat Dye Powders "Fine" and Acetate Dyes at I.G. Farbenindustrie A.G., Ludwigshafen...	4	8
1078	Metal Hose, Pipe Line Compensators and Metal Expansion Joints in Germany	1	1
1111	German Wind Turbine Projects Planned during the Hitler Era...	3	2
1114	Recent German Research Work on Fluorine and Fluorine Compounds	6	2
1116	Quick Calculation of A.C. High-Voltage Overhead Lines	2	2
1117	Treatment of Spent Pickling Liquors Containing Sulphuric Acid and Iron Sulphate	4	2
1136	The Pressure Hydrogenation of Sulphite Liquor: Report in German	1	7
1154	High-Temperature Chlorination of Methane at Hüls	1	1
1162	Steel Production by Vacuum Electric Furnace at Heraeus Vacuumschmelze, Hanau ...	1	1
1165	Production of Mixed Steels in Germany	1	1
1168	The "C" Process of Making Moulds and Cores for Foundry Use	1	4
1185	Recent German Developments in the Field of Dental Resins ...	1	7
1194	Production of Inorganic Phosphate Salts at Bayerische Stickstoffwerke, A.G. Biesteritz, Germany	1	1
1208	Supercalendering of Condenser Paper	2	2
B.I.O.S.:			
JAP/PR/82...	Activities of the Research Institute for Light Metals for Aviation, Tokyo	1	1
JAP/PR/116	Electrical Equipment and Accessories for Japanese Aircraft ...	1	4
JAP/PR/1298	Characteristics of Japanese Naval Vessels: Boilers and Machinery	9	3
	Classified List No. 8, Consolidated list under Subject headings of all reports on German and Japanese Industry published up to and including May 31, 1947	1	3
	Classified List No. 9, June, 1947, Supplement to the above list		3
	Classified List No. 10, July, 1947, Supplement to the above list		3
	Technical Index, Alphabetical subject index of all reports on German Industry published up to and including July 27, 1946	5	3
C.I.O.S.:			
XXXIII—71	Tyre, Tube and Heavy Plant Manufacture (Appendix No. 14a to C.I.O.S. Report XXXII—119)	9	2
B.I.O.S.:			
714	The Development of New Insecticides	6	2
1356	Grinding and Treatment of Minerals	9	3
1443	The German Nitrogenous Fertiliser Industry (excluding Cyanamide) in the Western Zones	17	10
1494	Developments in Aircraft Construction Using Plastic, Paper, Veneer and Thin Metal in Sandwich and other Formations ...	6	2
1539	German Chlorate Industry ...	3	2
1540	German Cork Industry (Natural and Composition) for Bottle Closures, &c.	2	2
1559	Starch and Starch Adhesives Industry in Western Germany	3	8
1570	Steel Sheathing of Electric Cables by the Hackethal Process	1	7
1575	Carbonyl Nickel and Carbonyl Iron Powders, their Production and Properties (Interrogation of Dr. Leo Schlecht)	3	8
1576	Manufacture of Saccharin and its Intermediates at I.G. Farben Factories	2	2
1586	Yield and Wood Waste Utilisation in German Hardwood Plywood Plants	2	2

Technical Information and Documents Unit, German Division, Board of Trade, 40, Cadogan Square, S.W.1, which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

A Seven-Day Journal

Ministry of Supply Research Appointment

THE Ministry of Supply announces that Dr. F. J. Wilkins, M.Sc., has been appointed Principal Director of Scientific Research (Defence) in succession to Dr. E. T. Paris, with effect from May 1, 1948. He will be responsible, under the Ministry's Controller of Supplies (Munitions) and the Chief Scientist, for research on munitions and allied equipment. Dr. Wilkins was born in 1905 and was educated at the Technical College, Cardiff, and the universities of Cambridge and London. From 1927 until 1930 he was engaged in research on reaction kinetics with Professor Rideal at Christ's College, Cambridge, and after gaining the D.S.I.R. Senior Research Award, worked until 1933 in Professor Donnan's laboratory at University College, London, on gaseous absorption. He then joined Imperial Chemical Industries, Ltd., Billingham Division, where, until 1941, he was engaged in production, plant design and research dealing with chemicals and acids. At the outbreak of war Dr. Wilkins was resident manager for the Billingham Division in charge of the start-up and proving trials of a number of plants at Government explosive factories. During this period he designed a new type of ammonium nitrate plant. In 1941 Dr. Wilkins joined the Ministry of Supply and was appointed Regional Development Officer (Western Region) for the Royal Ordnance filling factories, where he led a research and development team which designed a mechanised method of filling small and medium-calibre shells. Subsequently, he became Deputy Chief Superintendent of Armament Research at the Ministry, and for two years has been Director of Chemical Research and Development.

Humphrey Gainsborough, 1718-1776

ON Wednesday, April 28th, the bicentenary of the settlement of the Rev. Humphrey Gainsborough as minister of Henley Congregational Church was commemorated there, and a brochure was issued by the Rev. George H. Peters, the present minister. Gainsborough was a member of a talented family, another brother being the celebrated painter. Humphrey had the reputation of being an ingenious and skilful engineer. He superintended river improvements on the Thames and was awarded premiums by the Society of Arts for improvements in agricultural implements; but what interests us is that when Watt was applying in 1775 for an extension of his patent for the separate condenser steam engine, Gainsborough petitioned for a patent for an "engine . . . much more useful . . . than the common steam engine by having much greater power and velocity." This drew from the optimistic Boulton a letter to the pessimist Watt: "Let us make hay while the sun shines and gather our barn full before the dark cloud of age lowers upon us and before any more Tubal Cains, Watts, Dr. Fausts or Gainsboroughs arise with serpents like Moses that devour all others. . . ." Gainsborough was not granted a patent—he was in ill-health at the time and died on August 23, 1776—possibly because the Attorney-General found that Watt had anticipated him.

Report on the Southern Railway Motspur Park Junction Collision

THE report of Lieut.-Colonel G. R. S. Wilson, Inspecting Officer of Railways to the Minister of Transport, following the inquiry into the collision which took place on November 6, 1947, at Motspur Park Junction, where the Chessington branch connects with the double line of the Southern Railway from Raynes Park to Epsom, Leatherhead and Dorking, has now been published by the Stationery Office. The accident occurred in dense fog at about 5.50 p.m. The 4.45 p.m. up electric passenger train from Holmwood to Waterloo passed at danger the Motspur Park up main (Leatherhead line) outer home signal, having received a clear hand signal from the fog signalman stationed there. After travelling nearly 300 yards it collided sidelong with the 5.16 p.m. down electric passenger train from Waterloo to Chessington, which was crossing its path under clear signals at the right-handed double-line junction. Both trains were well loaded and four passengers lost their lives, all in the leading motor coach of the Waterloo train. Eight passengers were detained in hospital and ninety-two others complained of minor injuries or shock. In his remarks, Colonel Wilson says that the collision was due to failure of the human element in circumstances which admitted of no excuse. The fog signalman's duties, he says, required nothing more than conscientious observance of clear and simple instructions.

Institute of Transport's Headquarters

IN our issue of August 8, 1947, we announced that the Institute of Transport had purchased the lease of No. 80, Portland Place, London, W.1. On Friday last, April 30th, this house was officially opened as the Institute's headquarters by Mr. T. W. Royle, M.V.O., the President. The building, which provides accommodation for all the amenities of the Institute, has been adapted under the direction of Mr. Howard Lobb, F.R.I.B.A., and appreciation of his work and that of the contractors was appropriately expressed by the President. Mr. Royle also said that it remained for the members to make the Institute's new headquarters a vital centre of service to the cause of good transport. It was not enough to be pleased with a handsome building; it must be used and developed to the utmost for the promotion of education, research and discussion. The President announced that the Endowment Fund had now passed £64,000, an achievement which was largely a monument to the zeal of Sir Frederick Handley Page, and in recognition of Sir Frederick's services, the Council had elected him to honorary membership of the Institute.

The Late Mr. William S. Knudsen

LAST week news was received from America of the death, at the age of sixty-nine, of Mr. William S. Knudsen, who from 1937 to 1939 was president of General Motors, and in the last war was entrusted with the organisation of the United States engineering industry for defence. He died at his home in Detroit on Tuesday, April 20th. He was born in Copenhagen, was educated at the Government Technical School and served his apprenticeship with a cycle manufacturer. He showed a special gift as regards mathematical studies. About the age of twenty Mr. Knudsen emigrated to America and worked as a fitter with the Gas Engine and Power Company, of New York. After a short period with the Erie Railroad, on boiler work, he joined, in 1902, the Buffalo firm of John R. Keim Mills. That firm, in addition to cycle manufacturing, made motor-car parts, and in 1911 it was taken over by Henry Ford. Mr. Knudsen had by that time risen to superintendent of the works, and his administrative talent was soon recognised. He played an important part in the planning and building up of Ford assembly plants in many parts of the United States and, among others, was responsible for introducing the moving belt principle for engine and motor-car manufacture. During the First World War Mr. Knudsen was in charge of the Ford River Rouge plant, and by 1921 he became a leading Ford production executive officer. About that time he joined the firm of Matthews and Ireland, as general manager, and in 1922 he was appointed vice-president of the Chevrolet Motor Company. In 1933 he became executive vice-president of the parent company, General Motors, with control of its motor-car, body and engine manufacturing activities, and in 1937 he was made president. In 1939 he joined the Advisory Commission to the Council of National Defence, and in 1941 was elected Director-General of the Office of Production Management. In 1942 he was appointed Director of Production for the War Department with the rank of lieutenant-general, a position he held until the end of hostilities. He was well known and liked in England, and throughout his career he earned the high esteem of those who worked with him and the men who worked for him.

Illumination Exhibition at the Science Museum

THE illumination exhibition at the Science Museum, South Kensington, which has been arranged to mark the growth of electric lighting in the century since Joseph Wilson Swan began his researches in 1848 on carbon filaments, which led to the first electric lamp, was opened on Thursday, April 29th, by His Majesty the King. It is called "Darkness into Daylight," and a small illustrated booklet bearing that title has been prepared by Mr. W. T. O'Dea, B.Sc., A.M.I.E.E., and is published at 1s. by the Stationery Office. The exhibition will remain open until the end of September. In the first section examples of early lamps and means of illumination are shown. Progress is illustrated by a survey of lighting from the Middle Ages up to the early nineteenth century. The coming of gas lighting and electric lighting is displayed in diorama form, as also is the corresponding development of lighting fittings. The invention of the electric filament lamp is fully described, and some of Swan's original electric lamps are on view. The development of various types of lamps for street lighting, medical purposes and for theatre, film and television lighting is reviewed. Two final sections of the exhibition deal fully with the researches made on fluorescent materials, and the successive stages in the development of fluorescent lighting in its various forms for the street, the factory, the office and the shop. An example of the Zenon arc lamp, water cooled, and taking 5000W, is exhibited, as showing the best colour rendering qualities of any discharge lamp yet produced. The efficiency and economy of fluorescent lighting is explained, and an indication of future lighting developments is outlined.

Commercial Vehicle Firms' Merger

IN a Journal note of February 27th, we outlined the proposal of the Associated Equipment Company to acquire the issued shares of Crossley Motors, Ltd., a scheme which has now been approved by the shareholders of the two companies. In the statement by Mr. O. Douglas Smith, the chairman of the Maudslay Motor Company, Ltd., of Coventry, covering the year ended August 31, 1947, which was recently issued, reference is made to the close interests of the Associated Equipment Company and the Maudslay Company which has been in part competitive, but largely complementary, with an extremely pleasant relationship between the two concerns. As a result of recent conversations between officials of the two companies, and a consideration of the world economic outlook, it was made clear that both undertakings could benefit still further by financial unification. With this end in view, a notice has been sent to the shareholders, informing them that the Associated Equipment Company, Ltd., has made an offer to acquire the whole of the issued ordinary shares of the Maudslay Motor Company, Ltd. It is proposed that one unit of £1 ordinary A.E.C. stock will be issued to holders of ordinary shares in the Maudslay Company who accept the offer, for every four 5s. shares held by them. The offer is conditional on its being accepted by 90 per cent of the shareholders or such less proportion as the A.E.C. may agree. The separate identity of the Maudslay Company is intended to be preserved, and its relations with the A.E.C. will be strengthened by the appointment of Mr. O. Douglas Smith, to the board of the Associated Equipment Company, Ltd.

The British Industries Fair

No. II—(*Continued from page 417, April 30th*)

WE continue below our description of some of the more novel and interesting exhibits at Castle Bromwich, Birmingham.

Hordern, Mason and Edwards, Ltd.

A press on the stand taken by Hordern, Mason and Edwards, Ltd., Pype Hayes, Birmingham, is shown in actual production making aluminium stew pans, 12¼in diameter by 8in deep.

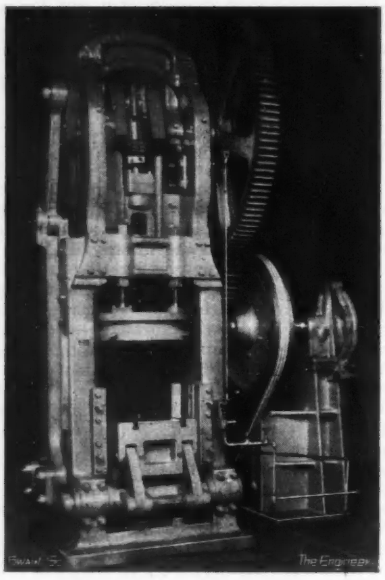


FIG. 6—RISING TABLE PRESS—HORDERN

This machine, which is illustrated in Fig. 6, has a rising table and is equipped with a pneumatic clutch and brake release. It is designed to deal with up to 16 S.W.G. steel when blanking work up to its maximum diameter of 26in and can punch work up to 18in diameter. Articles in all classes of material can be drawn to depths up to 10in on the machine. With this type of press the table is raised by steel toggles, which take the thrust whilst a blank is being drawn. At the end of the working stroke the table descends clear of the pressed article, allowing the operator ample time for extracting and loading for redraw work. End play in the toggle mechanism is automatically taken up by the weight of the table and the die.

An adjustable ejector under the table, which comes into operation during the downward movement of the table, can be removed when it is required to draw through the die. The blank holder remains stationary, whilst the punch and the table move in opposite directions. By removing this holder the machine can be used as a single-action press, which, with the combined movement of the table and slide, makes available an exceptionally long stroke of just under 24in.

The crankshaft is driven through gearing by an electric motor on an adjustable bracket pivoted to an outside pedestal. Drive from the motor is first taken through vee ropes to a flywheel mounted on roller bearings. The machine is driven through an air-operated clutch. A crank set outside the main frame, and at the end of the crankshaft opposite to that on which the driving gear is mounted, operates the heavy side links actuating the table toggle mechanism.

By means of a single lever on the right-hand frame member the operator has complete control of the starting and stopping of the machine at any point in its working cycle through the medium of the pneumatic clutch.

F. Taylor and Sons (Manchester), Ltd.

A versatile mobile crane which is being shown by F. Taylor and Sons (Manchester), Ltd., 136–140, Bolton Road, Pendleton, Salford, is illustrated in the accompanying engraving, Fig. 7. It is known as the "Jumbo Crane," and is designed to lift 2½ tons to a height of 16ft 9in or up to 2 tons to a height of 17ft 6in. A number of attachments are available with the machine, including a ¾ yard shovel, a ¾ yard excavator bucket, an elevating platform, lifting forks and a pole clamp. These attachments are mounted on sleeves which fit over the end of the jib and are quickly and easily secured by a single screw clamp. A steel plate fitted to the front of the chassis and a hook at the rear enable the machine to be used for shunting or towing purposes.

The crane is mounted on a rigid four-wheeled chassis driven by a 30 h.p. engine. It has four forward and one reverse speeds, and is designed for rear wheel steering, the minimum outside turning radius being 13ft. A power take-off from the engine drives a hydraulic pump which supplies the power for actuating the crane jibs.

The crane proper consists of two fabricated lattice steel jibs, the lower one of which is raised and lowered by two vertical hydraulic jacks positioned about midway along its length. The motion of this lower jib is transmitted to the upper jib by two rollers which move along a special track fitted to the underside of the upper jib. The front section of the upper jib is hinged just forward of the roller track. A tiebar linkage to this hinged front section of the jib maintains its end in the same position relatively to the crane body during all movements from maximum to minimum elevation.

The hydraulic jacks actuating the crane jibs are controlled through a single valve in the driver's cab. This valve is set by a small hand lever to raise, lower and hold the jibs in any position. When the control lever is released it automatically returns to the "hold" position and jib movement ceases.

A. Reyrolle and Co., Ltd.

Equipment exhibited by A. Reyrolle and Co., Ltd., includes representative examples of metal-clad and open-type switchgear alongside a selection of relays and demonstration panels of protective systems for feeders and bus-bar zone protection.

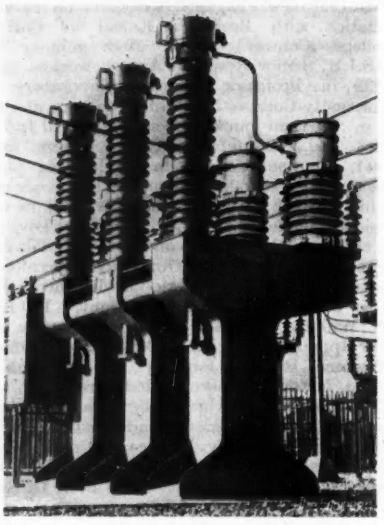


FIG. 8—66-KV CIRCUIT BREAKER—REYROLLE

Occupying the centre of the stand is a 66-kV small-oil-volume, open-type circuit breaker. This equipment uses a single break and is pneumatically operated from a local air receiver and an operating cabinet fitted to one supporting frame. Designed for power stations and major transmission sub-stations, this switchgear unit has a making-capacity and breaking-capacity rating of 1500 MVA.

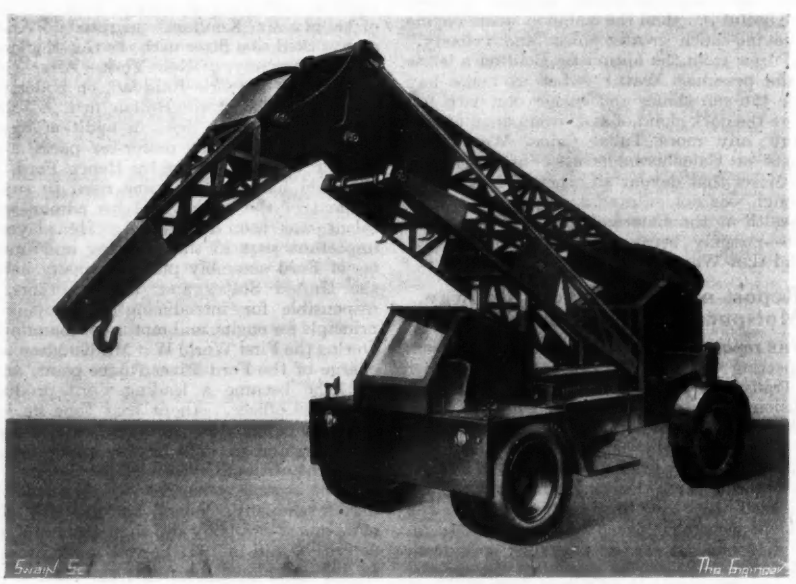


FIG. 7—MOBILE CRANE—TAYLOR

Three post-type current transformers mounted on the framework adjacent to the circuit breaker have (like the circuit breaker itself) a low oil content. A unit, generally similar to that exhibited, is illustrated in Fig. 8.

Each phase of the circuit breaker proper consists of two portions. The lower portion provides insulation from earth and supports the upper portion which takes the form of a bushing containing the circuit breaking chamber. This bushing comprises a hollow bakelised paper cylinder enclosed by a shedded porcelain for weatherproofing. Above this bushing is a centrifugal separator, which allows the gases generated on short-circuit operation to escape without loss of oil. Two oil level indicators and a silica gel breather are fitted on the outside of the upper unit, the oil being divided into two separate portions. The oil in the circuit breaking chamber forms the arc quenching medium and requires reconditioning after clearing a short circuit; the remainder of the oil in the lower portion is used for insulation and is not contaminated.

Arc control is achieved by the well-established Reyrolle block type turbulator, which consists of blocks of insulating material assembled to form an enclosure surrounding the contacts but vented transversely by a series of openings proportioned to suit the current to be broken. Magnetic bias is provided to direct the arc towards the vents in a favourable position for extinction.

The upper fixed contact and the turbulator are fixed to the base of the chamber containing the centrifugal separator. The member carrying the moving contact consists of a metal tube with an outside diameter just smaller than the throat of the turbulator. A fixed piston is fitted within this tube so that when the tube moves downwards on breaking circuit the column of oil inside it is forced into the turbulator.

Three examples of protective gear are exhibited, including the recently designed mono-bias system of bus-bar zone protection, which is specially applicable to major generating stations and switching stations where continuity of supply and discrimination are vital considerations. The mono-bias system is based on the well-known Merz Price current balance principle, but incorporates, in addition, a novel biasing element which is claimed to be effective in external faults of all kinds.

John Mills and Co. (Llanidloes), Ltd.

The well-known range of "Oilaulic" hydraulic pumps, presses and riveters to be seen upon the stand of John Mills and Co. (Llanidloes), Ltd., of Llanidloes, Mont., includes a new motorised bench-mounting press of 6 tons capacity. This machine has been designed particularly for use in the ceramic industry, where an extremely sensitive control is necessary to provide the varying pressures required at different stages of working.

A 100-ton horizontal, electrically driven hydraulic press which is being exhibited by the firm is a development of the 60-ton general-purpose machine used extensively for bending and rectifying heavy section rails, beams, cooliery props, roof bars, &c. As can be seen from the photograph we reproduce in Fig. 9, the machine is entirely self-contained and, if desired, the main pump motor can be replaced by a rotary compressed air motor or a suitable internal combustion engine.

The main frame of this machine is built up of 2in steel plates to form a rigid structure within which is accommodated the oil supply tank containing the hydraulic power pump. The rear ends of the frame side members are designed to form a rigid backing for the cast iron cross beam on which the anvil blocks are adjustably supported in tee slots. In the opposite end of the frame is rigidly mounted the cast steel press cylinder of the ram which actuates the hydraulic beam. This ram, which has a working stroke of 12in, has fast forward-approach speed of 24in per minute and a power speed of 8in per minute. Its return speed is 48in per minute.

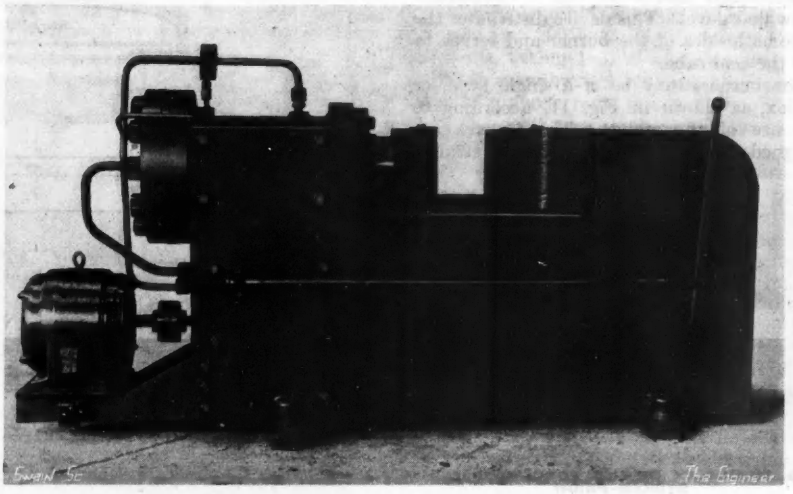


FIG. 9—100-TON HORIZONTAL HYDRAULIC PRESS—MILLS

Hydraulic power to the ram is supplied by one of the firm's "Oilaulic" 2A high-speed, high-pressure pumps driven by a 5 h.p. electric motor running at 960 r.p.m. This pump is designed to deliver oil at 3000 lb per square inch and is combined with a low-pressure pump. The control lever for the hydraulic operating valve in the pump tank is situated at a convenient working position near the resistance beam, and has three positions—neutral, forward and return.

In order to facilitate the loading and manœuvring of heavy work between the anvil and the ram die rollers are set in the table of the press. A load indicator is provided in a convenient position at the back of the hydraulic cylinder and shows clearly the total pressure in tons being exerted on the ram.

Prior Stokers, Ltd.

In arranging for the stoking of boilers it is often convenient to be able to convey the fuel directly from a bunker to the boiler, thus eliminating the necessity of filling a coal hopper by hand or by elevating and conveying gear. Amongst the exhibits of Prior Stokers, Ltd., 1–3, Brandon Road, York Way, London, N.7, is a mechanical stoker designed to feed directly from a bunker, and made in sizes to feed from 30 lb to 1000 lb of coal per hour with a single burner, and with higher ratings with twin burners. The only labour required is for clearing the fires.

The accompanying diagrammatic view, Fig. 10, shows the construction of this stoker, known as a bunker flow underfeed stoker. It comprises a specialised form of underfeed screw below floor level, together with forced draught gear, driven by an electric motor. The coal screw and tube are built in three separate portions, the bunker portion, the central portion and the burner portion. These parts are connected by combined inspection boxes and coupling sleeves. Coal is conveyed from the bunker by a screw which increases in diameter and pitch at the point where it leaves the bunker, so that the tube below the firing aisle runs only half-full. The coal is claimed to be conveyed quite freely without crushing or packing, and is fed past the jaw couplings between sections of the tube without tendency to jam.

The driving motor and gearbox are set forward of the bunker and the screw drive is taken through an enclosed countershaft to the rear of the bunker and coupled to the end of the coal screw by spur gears. The whole unit is sealed against coal dust and moisture, and ball or oilless bronze bearings ensure that attention to this part of the gear is not necessary. A worm reduction gear and pawl and ratchet drive are incorporated, affording a neutral and three or five rotational speeds for the coal screw, according to the size of the stoker. Overloading is guarded against by a shear pin, which can be replaced quickly

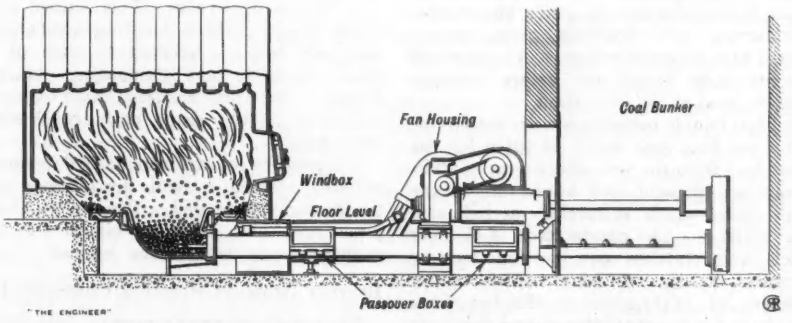


FIG. 10—BUNKER FLOW UNDERFEED STOKER—PRIOR STOKERS

without tools. The bunker front plate incorporates a crusher block, which can be withdrawn for clearing an obstruction in the coal tube.

On an extension of the gearbox spindle is mounted the runner of a centrifugal fan, from which forced draught is led through parallel-sided ducts to the "windbox" below floor level. This device distributes the air to both sides of the burner and serves to cool the coal tube.

The burners may be of a single type, or duplex, as shown in Fig. 11, according to the size of the stoker. The tuyeres are designed to accommodate expansion strains,

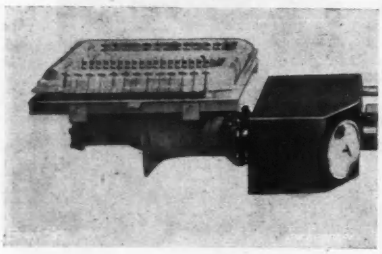


FIG. 11—DUPLEX BURNER FOR UNDERFEED STOKER—PRIOR

and the ports are of venturi form, so as to prevent ash and coal dust falling into the air chamber.

Totally enclosed motors, rated at ⅓ h.p. to 6 h.p., according to the stoker size, are of standard type, running at 1450 r.p.m. They are provided with overload protection, the smaller single-phase machines having either an in-built thermal switch or a separate Allen West circuit breaker. Other models have a control box for a three-phase Igranic contactor, overload protection and fuses.

This type of stoker is made in four "standard" sizes, rated from 240,000 B.Th.U. to 600,000 B.Th.U. and ten "duplex" sizes, with ratings from 725,000 B.Th.U. to 8,000,000 B.Th.U.

DAVID BROWN AND SONS (HUDDERSFIELD), LTD.

A new oil-controlled marine reverse-reduction gearbox exhibited by David Brown and Sons (Huddersfield), Ltd., is one of a range of such gearboxes that has been designed by the firm to meet the requirements of marine engineers. The range is suitable for tugs, trawlers, coasters and pleasure craft. Whilst the example shown at the Fair is a reverse-reduction model, other models are available for reverse only.

The unit shown is designed to transmit 510 h.p. at 600 r.p.m. input and 302 r.p.m. output. Its ahead life is given by the makers as 52,000 hours, and, astern, 6500 hours. The drawing reproduced in Fig. 12 shows the construction of the gearbox. It comprises two constant-mesh gear trains, the astern train including an idler gear. Multi-groove clutches are operated by oil pressure to engage and disengage the gears, the control lever having three positions, giving ahead, neutral and astern motions. An interlock prevents both ahead and astern clutches being engaged at the same time.

Hobbed double helical gears are employed, with a working face width of 10¼in for the ahead and 9¾in for the astern gears. The pinions are pressed and keyed on to the input shaft, which is carried on ball and roller bearings. The construction of the gear wheels and clutches can be followed by reference to the drawing. Steel outer members of multi-grooved clutches form side plates for the gear wheels, and the inner members, of bronze, are splined to the output shaft. At the forward end of the output shaft are paired bearings to take propeller thrust.

Situated at the bottom of the gearbox are two of the firm's 6H Roloid oil pumps, driven

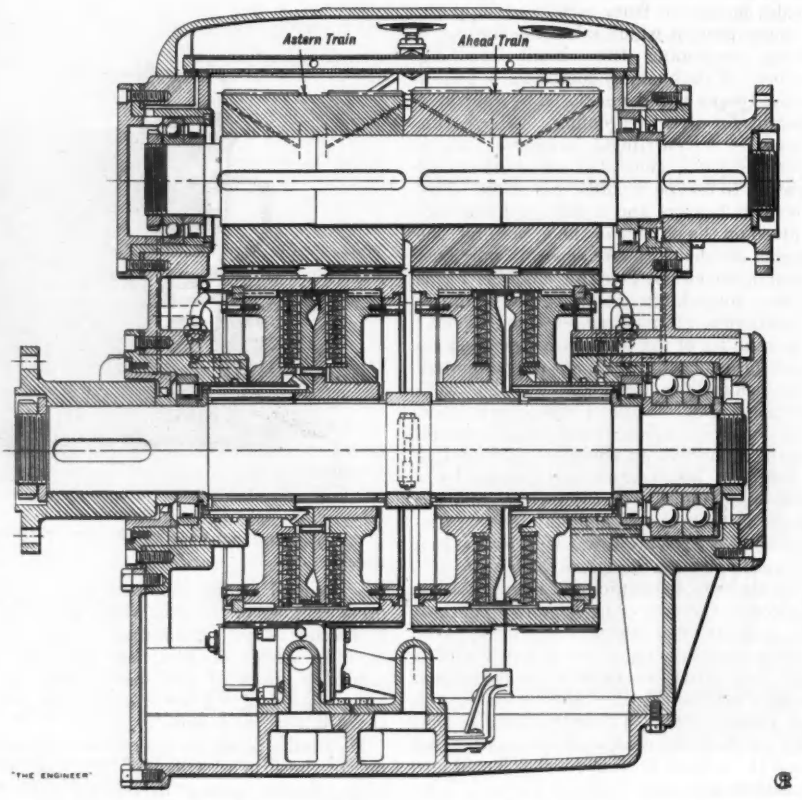


FIG. 12—MARINE OIL-OPERATED REVERSE-REDUCTION GEAR—DAVID BROWN

from the astern wheel, fitting into a housing which facilitates their assembly and dismantling. They serve to lubricate the gears and bearings and to provide oil under pressure for operating the clutches. Both run continuously, but only one is on load at a time, the other acting as a standby. An external lever permits a change-over of load from one pump to the other quickly so that continuity of oil supply is obtained.

A housing bolted to the port side of the gearbox accommodates the gearbox controls, an oil strainer and a pressure adjusting valve. Pressure oil delivered from one or other of the pumps is led from the gearbox to an external heat exchanger, and thence back to the gearcase. In the gearcase the oil passes through a pressure relief valve and the strainer, finally reaching the control valve and the pressure adjusting valve referred to above. A connection is also taken to a pressure reducing valve, oil at low pressure going to the gears and bearings and oil at high pressure going on to the control valve. This control valve, of the rotary pattern, has four outlet ports, one port being connected to each of the clutch engaging and disengaging cylinders. A stop on the valve ensures that it cannot be turned so as to engage both trains simultaneously.

The gearbox, of cast iron, has a flat, smooth exterior, and the controls are grouped so as to be easily attended. The only external pipes are those carrying oil to the heat exchanger and back to the gearcase.

BRITISH THOMSON-HOUSTON COMPANY, LTD.

Electrical equipment ranging from power station plant to fluorescent lamps and representative of the products of the British Thomson Houston Company, Ltd., Rugby, are on view.

Progress in welding control through the application of electronic techniques is well exemplified in the new design of standardised "Ignition" equipments for controlling

FIG. 13—"IGNITION" WELDING CONTROL EQUIPMENT—B.T.H.

seam, spot and projection welding machines. Many improvements have been incorporated in the new equipments compared with the

well-known FW 224L5 and FW24Q spot and seam welding controls.

A considerable reduction in size has resulted from the adoption of a new lay-out, in which all the timing circuits are built into a tray-mounted chassis housed in the upper part of the cubicle (Fig. 13). The tray, mounted on runners, is fitted with handles and can readily be withdrawn for maintenance. All the controls are grouped together on a sloping panel in the front of the tray and are protected by a hinged cover, which is shown open in Fig. 13. Two types of timing tray are available; one (form T) is designed for seam welding control, while the other (form L) is suitable for spot and projection welding. These forms of tray are fully interchangeable and no modification, apart from the interchange of trays, is required to convert the equipment from one function to the other.

Mounted on a panel in the lower part of the cubicle are the two water-cooled steel ignitrons, connected in reverse parallel to serve as an electronic contactor controlling the current in the primary of the transformer.

Whereas the older equipments had a warming-up time of eight minutes the new designs of control cubicle are ready for operation, as shown by three indicating lamps above the control panel, one minute after switching on the mains supply. The ignitrons are set in operation by closing the weld-initiating contactor, which energises the timing circuits causing the ignitrons to pass current for certain periods at regular intervals as determined by the setting of the welding cycle and duty cycle controls.

For spot welding the equipment operates under two main controls—a weld-time rheostat which sets the duration of the welding time, and a heat control rheostat which determines the value of the welding current by phase control of the ignitrons. The weld-time rheostat is calibrated in cycles; normally the setting is adjusted in steps of one cycle but welds of half-cycle duration can be effected. Operating in conjunction with a weld-time range switch, which provides "short" and "long" time ranges, the rheostat provides for settings of 1–14 cycles and 13–30 cycles, respectively. The heat control rheostat provides a much finer adjustment of welding heat by phase control of the ignitrons than can be obtained by the conventional tap-changing transformer. This rheostat operates in conjunction with a heat control range switch which selects "high" or "low" heat, as required.

The timing tray for seam welding provides similar controls but with two differences: first, the welding cycle range switch provides a short timing range of 2 to 9 cycles and a long range of 8 to 45 cycles; secondly, a duty cycle rheostat is included so that the relation between the heat time and welding time (heat time plus cool time) can be adjusted from 10 to 90 per cent.

Various protective devices are embodied in the equipments to guard against mal-operation or damage. To ensure that the thyratrons have reached their operating temperature before welding starts, a thermal time delay is fitted. A water-flow switch is mounted in the back of the cubicle to prevent welding from being started or continued unless sufficient cooling water is flowing through the ignitrons.

The equipment has a maximum rating of 2400kVA and operates from any single phase, 50 c/s supply between 220V and 550V.

Radio Heaters, Ltd.

The selection of industrial electronic equipment shown by Radio Heaters, Ltd., Wokingham, Berks, includes an interesting general purpose equipment for eddy current soldering, brazing and hardening.

A general view of the upper portion of the equipment is given in Fig. 14, which shows the controls and the worktable, which is slotted so that suitable jigs and fixtures for any particular job can be accommodated. The workpiece to be heated is placed within a

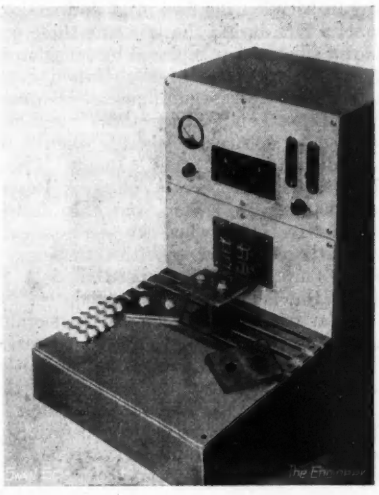


FIG. 14—EDDY CURRENT SOLDERING AND BRAZING EQUIPMENT—RADIO HEATERS

suitably shaped coil of one or more turns, connected to the output terminals of the "Radyne" C10A heater. Pressure on a foot switch then applies the radio-frequency output to the coil, and eddy currents are induced in the workpiece, causing the material to be heated rapidly. To ensure that the heat applied is independent of all normal supply mains variations an automatic electronic timer is included.

Power outputs up to 1kW can be delivered continuously into steel workpieces and 400W–500W into brass and copper, the frequency being approximately 400 kc/s. The silica oscillator valve (Mullard TYS 4/500) is guaranteed for 1500 hours and can be repaired at 60 per cent of the initial cost, the repaired valves also having a guaranteed life of 1500 hours. The input transformer is tapped for 200V to 250V, single-phase, 50/60 c/s, taking 1·5kW at full power and 150W at standby. A screened filter unit is fitted to suppress radio interference.

All the controls with the exception of the foot switch are conveniently arranged on a panel above the worktable, as shown in Fig. 14. Centrally disposed on this panel are the "coarse" and "fine" ten-way switches for setting the timer, covering the range of one second to one and a half minutes in 100 steps. The foot switch is situated in the centre of a large rubber-covered footrest, which forms an extension of the base of the cabinet. The overall dimensions of the equipment are 47½in high by 16in wide by 26½in deep, and the approximate weight is 240 lb.

A 12ft length of wire suitable for making heating coils is supplied with the instrument. If required, one water-cooled coil, suited to the customer's work, can be supplied. Water cooling is generally required for small, non-ferrous parts, which demand heavy heating coil currents. For such work the coils are of small diameter copper tube, and the water connections are made with rubber tubing to any convenient tap.

In addition to hardening, soldering and brazing, the equipment described can be used for many other heating processes, including annealing and shrinking-on, provided that suitable heating coils are designed and made for the particular work in hand. For continuous conveyor processes or for the heating of large parts, the worktable can be removed completely, leaving the front of the generator unit clear of obstruction.

(To be continued)

Ship Target and Other Trials

NO fewer than 100 British warships have been or are being expended in the Royal Navy's programme of ship target trials during 1947-48. All but a dozen of this "guinea-pig" fleet were new ships built during the late war. It comprised one of our largest aircraft carriers, H.M.S. "Furious"; 3 cruisers, the "Hawkins," "Emerald" and "Delhi"; 10 destroyers; 3 sloops; 16 submarines; 16 corvettes; 7 "X" craft; 6 M.T.B.s, and 38 L.C.T., C.F. craft, "E"-boats, and miscellaneous vessels.

Three of the destroyers were of the latest "Battle" class of super flotilla leaders. Another was the new cruiser-weight ex-German destroyer, "Z 30." All the submarines were of recent construction or completed toward the end of the war, two being of the latest "A" class of ocean-going boats.

Some of the trials took place last year in Loch Striven, in the Firth of Clyde, and off Portsmouth. The experiments were arranged to determine the effect of damage by under-water explosions at various depths, airburst bombing, static bomb detonations, magazine flooding, stowage of explosives, shock and flash, and aircraft attack against massed shipping.

The Admiralty has announced that tests of the effect of "near misses" with bombs, mines and torpedoes were being carried out on warships in Loch Striven. One cruiser, three British destroyers, an ex-German destroyer and smaller craft were being used for the trials. In certain of the trials which have already taken place in the Portsmouth area ships were subjected to direct hits.

The various phases into which the programme of ship target trials during 1947–48 is divided show how thoroughly the Royal Navy is going into the question of damage control and structural failure. Data obtained will be of advantage in the design and construction of new ships; but it is believed that before the real post-war naval building programme is embarked upon the technical material and lessons learned during the present series of tests will be embodied in experimental vessels.

The large and fast fleet aircraft carrier "Furious," which displaced 22,450 tons, played a prominent part in the ship target tests. On Loch Striven experiments were carried out in the ship to determine the effect of magazine flooding in aircraft carriers generally. Flash trials were also arranged, and tests were made as to the safe stowage of Fleet Air Arm explosives. Separate trials on the same site dealt with the safety of the stowage of rockets. The "Furious" was originally a cruiser with turbines of 90,000 s.h.p. intended to carry guns of the heaviest calibre ever designed—

18in—at a speed of 31 knots, but she gradually underwent transformation into an aircraft carrier over a period of eight years at a cost of £6 millions. After being used for target trials the "Furious," completed as an aircraft carrier in 1925, went to the shipbreakers.

Contemporaneous with the "Furious," the heavy cruiser "Hawkins" has been used as a target for bombing trials off Portsmouth. Of 9800 tons displacement, she mounts seven 7·5in guns, the largest hand-worked weapons in the Navy, and steamed at 29·5 knots with 55,000 s.h.p. Laid down in 1916 at Chatham Dockyard to counter a class of large German light cruisers, she was completed in 1919, and is now thoroughly obsolete and worn out.

Before the "Hawkins," which had long been laid up at Falmouth, was moved from her berth overhaul and repair was necessary, and arrangements had to be made on the ship for mooring to the target buoy. Watertight doors, trunking, vents, hatches, pipe systems, &c., had to be made capable of being closed and secured. All double-bottom oil fuel tanks and those abreast the boiler-rooms had to be pumped out and flooded with salt water. For use immediately before the static detonation portion of the trials arrangements were made to provide the "Hawkins" with a large number of damage-control components made in Portsmouth Dockyard for salvage purposes and repairs during trials. They included 500 wooden plugs of varying diameters from ¼in to 6in, 500 wooden wedges, 50 large mild steel plates approximately 4ft square and ½in thick, 6 wooden stools and a number of timber shores. The arrangements were undertaken by Reserve Fleet personnel at Falmouth, and the work was carried out after the arrival of the ship in Portsmouth Dockyard on April 1, 1947, for completion by the end of that month. Trials started in May.

The "Hawkins" was dry docked for proper examination and patching up ready to be towed away for a further programme of the important ship target trials to be carried out this year, the final stage of which will probably be carried out in the Clyde area. The trials will be concerned with static detonation experiments.

The object of the bombing of the "Hawkins" was to get data for the various ministries concerned in the development of bombs to be used against warships, and to obtain information for the Admiralty concerning the defence of warships against bombs. The Royal Navy also gained experience in damage control and action repairs.

The "Hawkins" was one of the most continuously run cruisers in the Fleet, and the way in which she stood up to the bombs at her age must be a source of satisfaction to her builders, Chatham Dockyard. A sister ship, H.M.S. "Frobisher," built in Devonport Dockyard during 1916–24, is to be part of the "Defiance" torpedo establishment.

Complete obsolescence cannot be attributed to the other large cruiser to be expended. H.M.S. "Emerald," of 7550 tons, was designed in 1917 to have a speed equal to that of any German light cruisers then existing or likely to be built, but her construction was not pressed after the war; begun at Armstrongs, she was towed to Chatham Dockyard for completion, and not commissioned until 1926, having been eight years under construction. She had turbines of 80,000 s.h.p., giving the then very high speed of 33 knots, and in addition to seven 6in guns and smaller weapons carried the phenomenal torpedo armament of sixteen 21in tubes. She is being subjected to shock trials and experiments in damage by underwater explosions on Loch Striven.

The cruiser "Delhi," begun in October, 1917, and completed in June, 1919, is one of the "D" class, displacing 4850 tons, the design of which merely constituted the lengthening of the hull by about 20ft, as compared with the standard light cruisers of the "C" class, in order to add a sixth 6in gun between the fore-mast and the fore-funnel; but during the late war these guns in open shields were replaced by considerably lighter 5in weapons of the United States pattern in closed gun-houses. Obtained under Lease-Lend terms, these guns were removed for return to America when it was decided to convert the "Delhi" into a stationary Royal Naval Volunteer Reserve Headquarters Drill Ship, but this decision was later rescinded when she was nominated as a target ship. With turbines of 40,000 s.h.p. she had a speed of only 28½ knots. She is now being scrapped.

Similar trials to those on the "Emerald," and in the same locality, are to be carried out with the new destroyer "Oudenarde." This ship is a unit of the latest "Battle" class of giant flotilla leaders displacing 2325 tons, designed with a view to operations in the Pacific, and was launched as recently as September, 1945. Associated with her in damage by underwater explosion and shock trials are the contemporary and even larger ex-German destroyer "Z 30"; the pre-war destroyers "Active," "Anthony" and "Brilliant" of 1350–1360 tons, and six motor torpedo boats.

To determine the effect of shock and damage by underwater explosions at various depths a number of trials is being carried out in Loch Striven on large and medium submarines. The "Ace," the largest, belongs to the new all-welded ocean-going boats of the "A" class, also designed for service in the Pacific, which have surface displacements of 1385 tons (1120 tons standard) and 1620 tons submerged, and a high surface speed of 19 knots with 4300 h.p. (8 knots and 1250 h.p. underwater). The medium (coastal) submarines are the "Upshot," "Urtica," "Vagabond," "Vigorous" and "Visigoth," of 658 tons (740 tons submerged). Six "X" craft, midget submarines displacing only 30 tons, are to be the subject of experiments in damage by underwater charges on a different site.

At Angle Bay bombs are to be detonated in place in the sloops "Bridgewater," "Folkestone" and "Weston," of 1045–1060 tons, launched in 1928–32. Airburst bombing trials are being carried out at Turbot Bank and Middle Ground on the "Flower" class corvettes "Balsam," "Campion" and "Le Malouine," of 925 tons, launched in 1940–42. Twelve tank landing craft, "E"-boats and C.F. craft constitute a special "guinea-pig" fleet for experiments concerned with aircraft attack against massed shipping.

Of particular interest are the trials to be conducted at Rosyth on two of the new "Battle" class flotilla leaders, the "Albuera" and "Namur," launched in the summer of 1945; L.C.T. "No. 523," and "J 4922." In these ships there will be static and dynamic loading to structural failure.

Preparatory work is in progress for trials concerned with submergence to collapsing depth on four different classes of submarines from "ocean-going" and "sea-going" boa s to "coastal" and "midget" types. They are the "Achates," of the "A" class, already described; the "Stoic" and "Supreme" of the "S" class, displacing 814–990 tons; the "Varne," of 658–740 tons, and an "X" craft, of 30·3–33·6 tons.

Six more "S" class submarines, the "Seadog," "Seanymph," "Shalimar," "Sybil," "Spark" and "Stygian," are concerned in trials on damage by underwater charges on Loch Striven with the destroyers "Amazon" and "Garland." The latter, of 1335 tons, was completed in 1936 and transferred to the Polish Navy in 1940. The "Amazon," also to be expended, is an experimental boat of 1350 tons completed in 1926 and noteworthy as the post-Great War prototype from which all our modern fast fleet destroyers were evolved. She had the then high shaft horsepower of 40,000, giving a (still high) speed of 37 knots.

Trials of 5·25in and 4·5in shell are being carried out off Portsmouth on the "Flower" class corvettes "Burdock," "Campanula," "Convolvulus," "Gentian," "Gloxinia," "Godetia," "Heather" and "Sunflower." In the same locality there will also be trials of 6in shell on four L.C.T.s, and of incendiary shell on the corvettes "Clarkia" and "Snowberry," while trials of C.F. weapons will be carried out on the corvettes "Celandine" and "Pimpernel," six C.F. craft, five "E" boats, and nine miscellaneous vessels off Portsmouth, and at the various localities of small craft. Tests as to the safety of stowage of squid ammunition will be arranged at Loch Striven with the destroyer "Amazon" and the corvette "Dahlia."

In the case of about a third of the fleet of 100 ships earmarked for ship target trials, tests are already in progress, and a few are complete.

It is understood that the series of experiments are largely in the hands of both technical officers of the newly formed Royal Naval Scientific Service and members of the old-established Royal Corps of Naval Constructors. Data will be pooled for the information of all the Admiralty departments and personnel concerned in the building of new ships and the design of equipment.

It was early in the war when the Admiralty discovered that the lack of detailed information and methodical investigation into damage to warships was a very serious handicap to the progress of ship design. Great efforts were required to overcome this difficulty at a time when manpower and facilities could ill be spared. Experience gained during the war provided a considerable amount of data concerning the types of damage likely to be sustained by ships in action, but these data were incomplete and left many questions to which reliable answers had to be obtained. Accordingly, when the end of the war was in sight in early 1945, plans were prepared for ship target trials against warships which would become surplus in peacetime, and which would be scheduled for breaking up. Certain of these trials were conducted during the spring and summer of 1947 in the Portsmouth area.

ATMOSPHERIC POLLUTION.—The Lord President of the Council, Mr. H. Morrison, was questioned in Parliament recently about the harmful effect of unwashed sulphur smoke on areas near power stations and as to the best method of its abatement. He was asked if, in view of the disputes between many local authorities and the Electricity Commissioners, he would instruct the Department of Scientific and Industrial Research to make an investigation. In reply, Mr. Morrison said that measurements of sulphur pollution in the air were being made by the D.S.I.R. in many parts of the country, including areas near power stations, and that some information was available on the effect of sulphur on buildings and vegetation. The Department, Mr. Morrison added, was already trying to find methods of removal of sulphur from the flue gases of power stations which would be less costly and troublesome than those at present in use.

100 B.H.P. Diesel Mines Locomotive

OUT of the total of 250 diesel locomotives ordered recently for underground service by the National Coal Board, 152 are to be built by the Hunslet Engine Company, Ltd., of Hunslet Engine Works, Leeds, and of these thirty-eight are of the 15-ton, 100 b.h.p. type, to a design which has been applied and used consistently in several N.C.B. areas since 1946, both for coal haulage and man-riding trains over steep grades.

Applied to rail gauges from 2ft 6in to 3ft 6in, these six-wheel locomotives have a maximum axle load of 5 tons and an actual working order weight of 14½ to 15 tons, according to the couplers and type of brake gear embodied. Where sleeper spacing is close this weight can be carried safely on 28 lb rails, though normally 35 lb a yard is the lightest rail section recommended. But on the wheel base of 5ft 3in such narrow gauges mean that the minimum curve round which the locomotive can haul a train is noted. It is the large extent to which machining and assembly of the locomotive frame and locomotive details are performed on jigs.

Engine Equipment

Power is provided by a Gardner 6 LW oil-engine set to give the maximum power used in the road transport applications, viz., 102 b.h.p. at 1700 r.p.m. The six cylinders are 4¼in by 6in and the specific dry weight of the engine about 17 lb per brake horsepower. To keep the electrical equipment—which must be strictly flameproof—to a minimum, air starting of the engine is provided through the medium of a Reavell rotary air motor.

Air for this service, and for the locomotive brake, sanding and transmission-control systems, is provided by a Reavell two-stage compressor with intercooler, belt driven from the oil engine. This compressor fills two main and two auxiliary reservoirs, and is provided with an automatic cut-out which operates when the charging pressure is reached.

In order to meet the requirements of the Mines Department of the Ministry of Fuel and Power, the whole equipment must not only be flameproof, but the exhaust must be properly conditioned to obviate any measurable CO content. The Hunslet conditioner and flamepacks are of the type that was granted the Buxton certificate in 1939. They comprise principally a flamepack of stainless steel plates with an intervening gap of 0·016in fitted to the intake manifold and exhaust box, and an exhaust conditioner embodying water, scrubber and separator compartments, the flamepack already mentioned, and then the final cooling and dilution of the exhaust by a blown current of air.

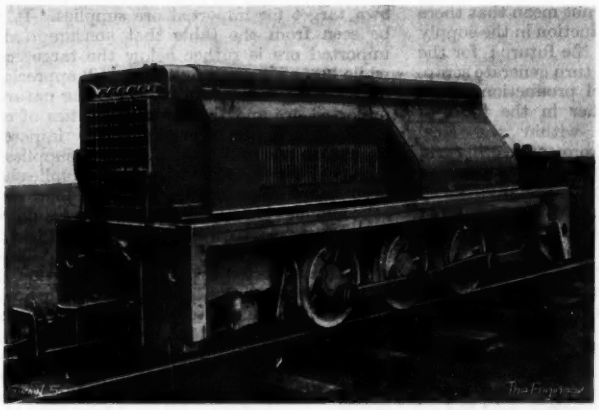
Engine cooling is on a thermostatically controlled system with centrifugal pump, fan, and Hunslet sectional radiator with quickly detachable and interchangeable Serck elements. Fuel tank capacity is 18 gallons.

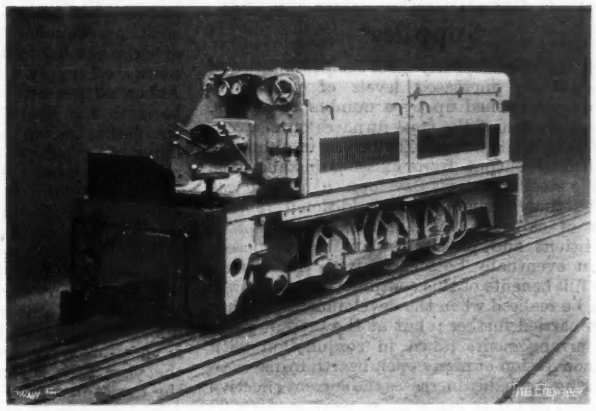
Transmission

From the engine the torque is transmitted through a high-capacity Ferodo-lined friction main clutch to a four-speed gearbox whose prime characteristics are robustness, the use of plain spur gears only, and the elimination of separate clutches for each gear step. The splines on the shafts are of an involute form evolved by the maker specially for locomotive gearboxes. All gear changing is carried out by a small hand lever, which operates automatic air servo-motors in an accessible position in the top of the gearbox. From the gearbox-driven shaft the torque is taken through plain spur gears to the jack-shaft, which is supported in Skefko roller bearings in the locomotive frame structure. Thence the drive goes to all six wheels through flycranks and rods. With the oil engine operating under full speed and load the track speeds and corresponding rail tractive efforts given by the transmission are: 4 m.p.h., 8000 lb; 6½ m.p.h., 5250 lb; 9½ m.p.h., 3500 lb, and 15 m.p.h., 2000 lb.

Auxiliary Details

The braking equipment is built to main-line locomotive standards, a practice followed by the maker in order to provide reliability in service, and robustness in the inevitable mines railway derailments. Westinghouse straight air brakes with a self-lapping driver's valve are used, and the automatic equipment for the application of train brakes is also included. In some of the 100 b.h.p. locomotives now at work the dual train pipes have not yet been fitted, as the tubs handled in coal hauling are unbraked. For maximum retardation the sanding system is connected with the brake control, so that in an emergency brake application the sanding is applied automatically. By the use of two large cylinders the requisite braking force is obtained through a very moderate leverage,





100-B.H.P. Diesel Mines Locomotive

about 70ft radius, if the drawgear used on the cars permits of the great lateral movement necessary, though running alone the locomotive can negotiate curves of under 60ft radius.

With a rolling resistance of 20 lb a ton, which is not too optimistic in the main ways of the modern pits for which this locomotive type is intended, a trailing load of 375 tons can be handled on the straight level at 4 m.p.h., i.e., on the lowest gear step. Under similar conditions the trailing load at 15 m.p.h. is about 150 tons. At the time the first locomotive was introduced in 1946 these values were, it is claimed, well ahead of previous possibilities in British pits.

Mechanical Problems and Construction

The outstanding problem to be met in applying diesel locomotives to the onerous physical conditions of the majority of British pits is that of getting within severely limited dimensions enough weight to take up fully the available engine power, and to provide adequate braking weight to control a train of unbraked tubs on steep grades. To provide a solution to these problems a one-piece locomotive frame structure cast in high-duty iron to B.S.S. No. 786 was adopted; there are a minimum of bolted or riveted connections and joints, and no ballast blocks are required. A consequence of this form of construction is that the frame casting contributes over half the total weight without involving cumbersome design, and the locomotive weight of 15 tons is contained within a length of 14ft 3in, a width of 4ft 6in and a height of 5ft 6in. This compactness enables the locomotive to be used, in practice, wherever there are rails of, say, 30 lb a yard or heavier, for the "right-angled curves" found in many subsidiary ways in bord-and-pillar mining usually have only the lightest rails. One further aspect may be a considerable advantage in pits where clearances and movements are restricted, and where lost motion and mechanical inefficiency in the rigging are a serious disadvantage.

Accessibility has not been neglected. The whole of the oil engine is easy to reach after the removal of the quick-release casing and similarly, the servicing of the engine, access to the gear controls, cleaning of the air, fuel and oil filters, and changing of flamepacks can be done easily. The air brake and pneumatic sanding equipment is protected by a light casing, which, when raised, enables inspection and adjustment to be carried out comfortably.

By the erection in these 100 b.h.p. locomotives of the Westinghouse equipment in one assembly, which can be lifted into or out of the locomotive as a complete unit, the advantage is gained that the erection and subsequent testing can be undertaken in any part of the shop and that the complete self-contained assembly can be brought to the locomotive after approval and immediately lowered into position. With a straight air brake, only two connections are necessary—to the brake cylinder and from the compressor—and an additional connection to the air starting motor for the oil engine where this is fitted. With straight and automatic equipment four connections are needed, the two additional ones being for the train pipes.

The framework carrying the Westinghouse equipment is made up of two ⅝in flanged steel end plates, the front one being cut away to clear the main clutch of the locomotive, and the rear plate acting as a cab weather-board with holes and cut-aways for the various gauges and operating levers. These two end plates are held together not by any structural longeron, but by the cylindrical air brake reservoirs, which have bosses on the ends into which are screwed set bolts passing through the end frame plates. As a whole, the assembly contains

not only the brake equipment, but the pneumatic whistle on the front plate, together with its connections from the air system, and a Gresham and Craven two-way valve and connections for the two-way air sanding. Also on the weather-board are two air-brake gauges, engine oil-pressure gauge, speedometer, electric tail lamp, and two flameproof electric fuse boxes, the connections for which are made by a flameproof plug and socket as the whole assembly is dropped into place on the locomotive.

The designer's task was more difficult in that all the space within the framework was not available for brake work. The top of the locomotive gearbox projects into the bottom of the space, the locomotive main clutch comes through the front plate, the fuel tank and sandboxes are in the top immediately below the cover plate, and clutch and gear-operating rods and levers and conduits for lighting cables also run through the space—many of them through the back plate.

The general appearance of the locomotive and the arrangement of the driver's cab and controls are shown in the accompanying engravings.

Steel Production and Scrap Supplies*

On the steel capacity side, the possibilities of substantially increased levels of production have been opened up by a number of factors. The operation of the steel furnaces on a seven-day week basis has greatly helped in obtaining additional output from existing installations. In the steel industry's development plan it was hoped that as much as an additional 750,000 tons of capacity, over and above the plant extensions and physical rebuilding proposed, might eventually be secured from this source. The full benefits of this continuous working will only be realised when the development plan has been carried further; but at the present stage the arrangement, taken in conjunction with the conversion of many open-hearth furnaces to oil firing, probably increases the current effective capacity of the industry by as much as 600,000 tons a year. About one-quarter of the steel ingot production of the industry is now based on the use of oil, which with its more rapid melting, gives a larger output from existing furnaces. On the production side the change has certainly been of substantial benefit, although the economies of oil conversion have been seriously prejudiced by the increase of up to 50 per cent in oil prices over the last eighteen months.

As a further help to increased output the industry is securing some of the early benefits of the modernisation programme. The rebuilding and enlarging of furnaces is constantly proceeding; and even apart from the building of major new steelworks, which inevitably takes a number of years, especially in present conditions, the fact that the development plan got under way soon after the end of the war is now proving of progressive benefit. These various factors combined mean that the capacity limit, even at the current production rates of about 15 million tons a year, is not fully reached and that the effective limit on the achievement of high levels of steel output lies in the field of raw material supplies. The following table shows the position regarding supplies of raw materials in the first quarter of 1948, compared with the forecast figures given in the Economic Survey :—

Iron and Steel—Targets and Performance, 1948
(Annual rates—thousand tons)

	Forecast (Econ. Survey)	First quarter result
Steel ingots and castings production	14,000	14,933
Scrap—Home bought (receipts)	3,700	4,436
Scrap—Imported (receipts)	850	455
Pig iron production	9,200	9,084
Ore consumption : home	13,470	11,959
Ore consumption : imported	9,040	8,845
Coke (including foundry and gas coke)	10,348	10,144

It is clear from the above statement that the high level of steel production reached in the first quarter has, in the main, been made possible by the substantial increase in supplies of home scrap to well above the target level required for 14 million tons of steel. The annual rate of receipts has been 736,000 tons above the Survey level. This, together with the increase in the tonnage of circulating scrap associated with the higher steel production, has largely accounted for the excess of steel production over the target level. The close association between this expansion of steel production and the increase of home scrap above the estimated figure is no coincidence. The whole point of the drive to secure the co-operation of industry in returning scrap quickly was that an increased supply of steel would thus be assured. It is, indeed, of the greatest importance, not only that the maximum possible supply of scrap should be secured by scrapping and throwing out obsolete plant and equipment, but also that ordinary process scrap arising in the course of manufacture should be sent back to the steelworks as quickly as possible. By accelerating the whole scrap cycle it is thus possible to obtain an expansion of steel production which, in turn, generates further scrap supplies. The breaking through to a higher level of steel production, made possible by quicker and larger returns of scrap, is a very real gain and does not mean that there need be a commensurate reduction in the supply of scrap coming forward in the future; for the extra steel supply will in its turn generate scrap. About 40 per cent of steel production comes back to the furnaces, either in the form of circulating scrap arising within the steel industry, or process scrap from engineering and other steel users; while some further tonnage comes back later in the form of capital scrap due to the scrapping which becomes possible as new industrial equipment comes into use.

The Survey target for 1948 home scrap supplies of 3·7 million tons was appreciably higher than any corresponding pre-war figure. In 1937 the amount thus secured was 3·4 million tons and in 1938 2·85 millon tons. It is therefore very encouraging to have started the year with such a substantial excess over the target figure. This is particularly so since, for a number of years to come, supplies of scrap from demolition of factories and other capital sources will inevitably be at a low level until re-equipment can take place on a larger scale. To quote only one example, the shortage of capital or demolition scrap is seen in the limited supplies at present available from old motor vehicles, which provided some 250,000 tons of scrap a year before the war. It is thus the improved supply of home bought scrap which is primarily responsible for the high level of steel production, and not the reduction in stocks to which the Chancellor of the Exchequer referred at his Press Conference on April 14th. That stocks of scrap and pig iron declined was in fact due to Government failure to implement the programme for imported scrap and coke supplies. Notwithstanding the shortfall in these two items, production has been carried forward to record levels on the assumption that the plans under these heads will eventually be carried out, and the deficiency for the time being has been made good out of stock. In fact, the stock reductions at steelworks in the first quarter amounted to 35,000 tons in the case of scrap and 80,000 tons in the case of pig iron (including stocks at blast-furnaces). This total reduction in the quarter of 115,000 tons (equivalent to an annual draw on stocks of 460,000 tons) was more than accounted for by the short fall in imported scrap of nearly 400,000 tons below the annual rate planned and a fall in coke deliveries of about 200,000 tons a year below the allocated rate. Almost the entire deficiency in coke supplies was in coke for pig iron making and represents a loss of pig iron production at an annual rate of about 180,000 tons. If, therefore, the coke allocations and the imported scrap programme had been implemented, it would have been possible, not only to have avoided any fall in pig iron and scrap stocks while achieving the recent record levels of steel production, but either to have restored the depleted stocks or even to have pushed steel production up to a higher level still.

This analysis re-emphasises the importance of achieving the coke allocation and of securing the planned imports of scrap from Germany.

The position regarding German scrap is particularly unfortunate as supplies of commercial scrap coming forward, out of an aggregate of about 10 million tons which a recent American report has stated is available in Germany, are almost negligible; and, even in the near future, they seem likely to amount to no more than 5000 tons a week at best. Yet at the very time when the authorities are apparently finding it impracticable to arrange for bigger deliveries of this type of scrap from Germany, facilities are being offered by the Joint Economic Control Commission for the purchase in dollars of substantial tonnages of imported ore for use in Germany. The figure for this year has been fixed at 1½ million tons, mainly from Sweden. This claim on imported ores by Germany introduces a new element of competition for the limited supply of rich ore at present available. At the very time, therefore, when there is a serious shortfall below the planned export of German scrap, which is embarrassing steel production here and leading to stock depletion, there is an increased claim on imported ore which is making it difficult to reach, and still more difficult to exceed, our own target for imported ore supplies. It will be seen from the table that consumption of imported ore is rather below the target rate, while home ore consumption is still appreciably below that level. Owing to the richer nature of imported ore and the lower quantities of coke it requires, it has been particularly important to use to the full the available supplies of imported ore at a time when coke supplies have been below allocations. With an increase in coke supplies home ore consumption would rise.

This short survey of the raw material position emphasises the view that unless supplies of coke and imported scrap can be raised quickly to the levels indicated in the Economic Survey there will be the greatest difficulty in maintaining steel production at the high rate which has so far been justified by the success of the home scrap drive. That steel production at a level of 15 million tons or more, if it could be secured, is urgently needed, is quite clear. Such an expansion in production would give the possibility, not only of achieving higher exports, but of carrying still further the expansion in some of the steel-using industries made necessary by the more limited possibilities in other sectors of the economy.

* Reprinted from the *Monthly Statistical Bulletin* of the British Iron and Steel Federation, April, 1948.

Technical Reports

The Present Basis of Axial Flow Compressor Design : Part I, Cascade Theory and Performance. By A. R. Howell, M.A. Reports and Memoranda, No. 2095 : Aeronautical Research Council, Ministry of Supply. H.M. Stationery Office. Price 6s.—The design of axial flow compressors is based on the performance of cascades of compressor blades, this performance being obtained from low and high-speed wind-tunnel tests and from theoretical considerations. This part of the report gives an analysis of the information available on the subject. It appears for low-speed cascade tests with a given pitch/chord ratio and air outlet angle that the stalling deflection of the air is, within certain limits, more or less independent of the camber and shape of the aerofoil. This dependence of the stalling deflection on only two parameters has enabled some very simple curves to be deduced for the variation of this deflection. Simple methods of obtaining the cascade losses are also given. The effect of Mach number on compressor cascades is closely related to the ratio of the throat area between neighbouring aerofoils to the inlet flow area, and values of this ratio less than about 1·1 should be avoided. Curves are given of the effect of Mach number on deflection and efficiency. The above test results are collected into a few simple design curves from which it is possible to obtain the performance of most present-day cascades over a considerable range of incidence, Reynolds number and Mach number. Various aerodynamic comparisons between and justifications for the methods adopted are also made and in particular a comparison is made between cascade and diffuser test results and reasonable correlation is obtained between these results.

A Commercial Vehicle Horizontal Diesel Engine

READERS of THE ENGINEER will recall that in our issue of May 24, 1946, we fully described the 0/600 six-cylinder, 600-cubic inch (9·8 litre) Leyland oil engine, which was at that time introduced as the new standard engine used by Leyland Motors, Ltd., Leyland, Lancs, for the post-war range of heavy-duty goods and passenger vehicles. A variation of that engine, in the form of the horizontal unit illustrated below, was recently shown for the first time at the Amsterdam Show. It has been designed to meet the needs of Continental chassis manufacturers for an underfloor power unit for transit-type buses, and we understand that orders are in hand, and some deliveries have been made, to makers in Sweden and Norway.

The main differences between the horizontal engine and the vertical unit is the redisposition of auxiliaries to give an overall height of less than 2ft. Redesigning has included a new shape of sump, additional external pipes for the water circulation system to prevent the formation of steam pockets, the inclusion of drainage pipes on the return side of the lubrication system, and the use of a new three-point flexible engine mounting.

As the engine is laid out, access to those units which require more frequent routine servicing is from the top and the left-hand side. The combined engine oil-filler and dipstick extends 32in from the centre of the engine on the left-hand side, but an alternative engine oil-filler component can be fitted which will extend 35in to give access when used on an 8ft wide bus.

The engine retains the same bore and stroke as the vertical unit of 4·8in by 5·5in, giving a cubic capacity of 597 cubic inches (9·8 litres). It develops an output of 125 b.h.p. at the maximum governed speed of 1800 r.p.m., with a maximum torque of 410 lb-ft at 900 r.p.m. In spite of the unit being mainly of cast-iron construction, it weighs only 1630 lb, less dynamo and starter motor. Fuel consumption is low, attaining a minimum of 0·34 pint per b.h.p.-hour up to 1200 r.p.m., and rising very slowly to 0·36 pint per b.h.p.-hour at maximum speed.

The C.A.V. fuel pump, which works in conjunction with the mechanical and vacuum-operated governor, is mounted on the top of the engine in a similar relative position to the fuel pump on the vertical 0/600 engine. Slightly forward of the pump and adjacent to the pump drive is a felt-and-cloth bag fuel oil filter. On the left-hand side of the engine on a platform thrown off from the sump is a 10 cubic foot air compressor, which is lubricated through a small external pipe connected to the main lubrication system. The compressor is driven by a separate twin vee-belt from the crankshaft. Alongside the compressor is a full-flow cloth-element lubricating oil filter, which is connected by a feed and return pipe to a drilled oil gallery in the crankcase wall. Also on the left-hand side of the engine and positioned above the sump at the rear is a 24V starter motor.

A second twin vee-belt, which is also taken from the front end of the crankshaft, drives the centrifugal coolant pump mounted forward of the cylinder block on the right-hand side of the engine. Each vee-belt has a tensioning pulley that is capable of fine adjustment, the pulleys being carried on fulcrum levers manipulated by large hand screws.

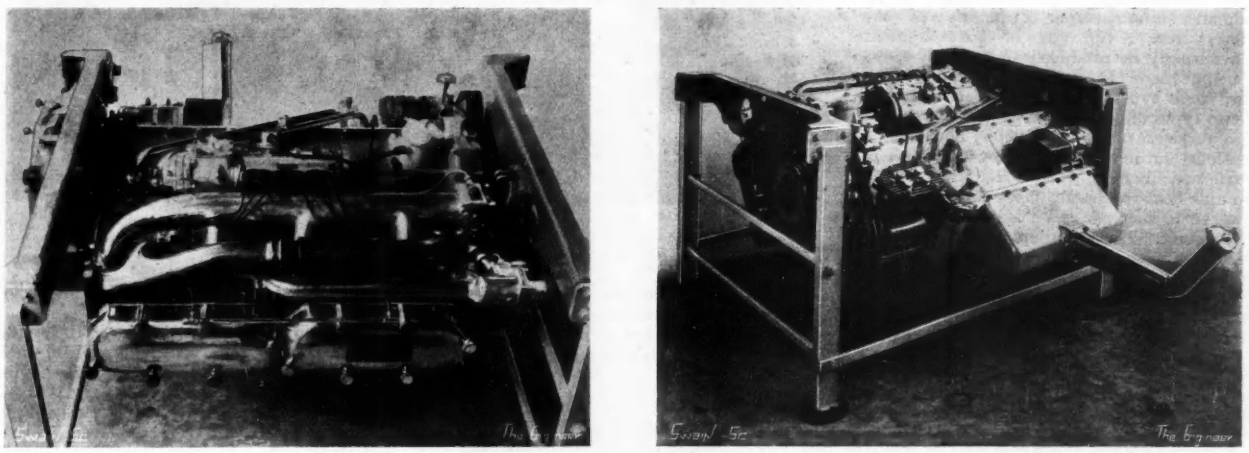
Although no fan is fitted on the engine, provision is made for taking a propeller shaft from the front of the crankshaft in order to drive a fan-mounted forward of the engine on the chassis frame. In the case of one transit-type bus utilising this engine, the radiator is mounted at the front of the chassis in the orthodox position and the fan is driven by shaft from the engine, which is mounted amidships in the chassis. Drives for auxiliaries can be taken from four points on the engine; from the crankshaft, the two tensioning pulleys, and the coolant pump drive. These drives are forward of the engine, but a drive to the rear can be taken from one of the tensioning pulleys.

The coolant system incorporates additional pipes to prevent the formation of steam pockets. These pipes are taken from the cylinder water jacket to the inlet side of the thermostat, the highest point in the system. Water drainage is a simple operation, for one large cock at the base of the engine drains the whole system.

Lubrication of the engine follows previous practice. The spur-gear pump delivers oil through a large filter to the main oilway on top of the crankcase. Drilled holes connect this oilway to the main bearings and so to the big-end bearings. The big ends are also drilled to deliver a spray of oil on to the walls of the cylinders. The oilway to the front main bearing acts as a feed to the idler gear bearing and to the teeth of the timing gears. A drilling across the front of the crankcase from the main oilway delivers oil through the centre of the hollow camshaft to its bearings. At each revolution of the camshaft, oil is forced from the second and fifth bearings into holes which pass through the cylinder heads, rocker brackets and hollow rocker shafts to the rocker lever bearings, lever pads and valve caps.

Oil is returned to the sump by gravity through drilled ducts to the lower ends of the push rods and tappets. To maintain this gravity feed to the sump, despite the angle of the road over which the vehicle is passing, two additional external pipes run from the tappet covers directly to the sump. When mounted in the frame, the engine has a tilt of 3 deg. from the horizontal to assist the oil drainage.

The three-point flexible suspension is a slight variation of the well-known standard Leyland flexible link mounting. At the rear, the engine is suspended by two link shackles fitted with Harris bushes, whilst at the front a single rubber-bonded mounting is used. As the flexibility is in the link mechanism itself, it is entirely mechanical in action and, besides being self-compensating, the links require no lubrication.



SIX-CYLINDER HORIZONTAL DIESEL ENGINE

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1.

METHODS FOR THE ANALYSIS OF STEEL

No. 1121, Part 2. This method is one of a series of standard methods of test for determining elements in steel and steel alloys. The specification provides for the solutions required, the test procedures and the method of calculation. Permanent-magnet alloys include alloys of the aluminium-nickel-cobalt-copper-titanium type. (An example of this type of material is the permanent-magnet alloy known as Alcomax.)

Part 3 specifies the method for the determination of tungsten in steels not containing columbium (niobium) and tantalum.

Part 4 specifies the method for the determination of aluminium in permanent-magnet alloys.

Part 5 specifies the method for the determination of copper in permanent-magnet alloys. The solutions required, test procedure and method of calculation are specified.—Price 1s. post free each part.

PIPE FLANGES FOR LAND USE: TABLES A, B AND C

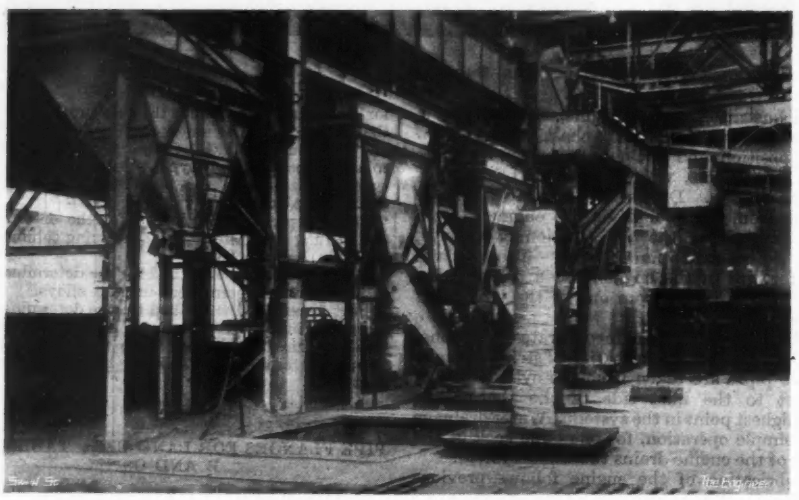
No. 10, Part I. This is a revision of the standard published in 1928 and gives dimensions of flanges made from cast iron, bronze, cast steel, wrought iron and malleable cast iron, for maximum working water pressures up to 400ft head (173 lb per square inch) at a maximum temperature of 212 deg. Fah. It has been customary to regard this standard as purely dimensional, despite the fact that the flange thicknesses were varied for different materials. A feature of this revision is that the minimum properties of the flange material have been included. A number of sizes have been deleted from the tables and the outside diameters of wrought iron and steel pipes up to 72in nominal size have been included. The appendix setting out the dimensions of short bends and tees of cast metal has been retained. Price 2s. post free.

A Large Engineering Works at Workington

WE recently accepted an invitation to visit the new works of the Distington Engineering Company, Ltd., which has been established at Workington, Cumberland, in a large factory built during the war by the Ministry of Supply. A little more than two years have passed since these premises were acquired, and in that time they have been completely reorgarised and equipped as a general ironfoundry and engineering works. In laying down its new works the company has concentrated upon the establishment of a complete self-contained factory equipped with the latest plant operating on modern economic lines and, so far as is possible, independent of outside sources of supply. At present some 1300 workpeople are employed and this number will ultimately be increased to 2000, when there is sufficient housing accommodation in the district. Housing restrictions are a major problem in the area at the moment, and already prevent the full productive capacity of the works being used owing to lack of suitable labour.

In addition to general engineering work the company has embarked upon the large-scale production of mining equipment, all of which will be manufactured under the licence of the Goodman Manufacturing Company of the United States. A full range of this equipment will eventually be produced and already there are being made three sizes of shaker conveyor, three types and sizes of belt conveyor and two types of coal cutter.

The works are not yet completely finished and extensions and new buildings now in course of construction include a steel foundry and a forge and heat-treatment shop, both of which will serve to increase the productive scope of the company. The main shop consists of five bays, 1280ft long, with an overall width of 375ft, served throughout by heavy overhead cranes and rail tracks leading to an adjoining private siding. This shop has been divided into two sections by a partition built across its full width; one section is mainly devoted to the ironfoundry and the other to machine and erecting shops.



MOULD RAMMING MACHINES

Work in the foundry falls into two categories: general iron casting production and moulding of ingot moulds, bottom plates and loam moulding of ladles for the iron and steel industry. The foundry has been in operation for some eighteen months and is producing about 900 tons of hematite castings a week. Ingot moulds weighing up to 18 tons each are made in large numbers on a highly mechanised production line. A group of machines which have been developed for this class of work can be seen in the photograph we reproduce. Each machine has a large rotating table which is set at the bottom of a pit. An iron core of appropriate size is set upright on the centre of the table in the middle of a mould box. With the table rotating, sand is fed at a controlled rate into the box through a chute leading down from an overhead hopper. This overhead hopper is kept filled by a conveyor belt which runs from the sand preparation plant along the full length of the machine line. An operator stands at the top of the pit and packs the sand down round the iron core by means of a pneumatic rammer. The ramming of the outer casing for the ingot mould is dealt with in a similar manner. When completed the moulds are removed by an overhead crane to drying ovens and, at the end of the drying period, they are taken to a central station where the metal is poured directly a sufficient number of moulds are ready. The mould boxes are knocked out on an adjoining floor grid, through which the sand drops on to a moving belt which conveys it to a central cleaning and reconditioning pit.

The general iron moulding section is situated in the centre of the foundry floor round which the mechanised ingot moulding line is arranged. This section of the foundry has also been mechanised and is equipped with a representative range of modern plant. At present its output is restricted to some 30 tons of castings a week, although its productive capacity is in the region of 150 tons a week.

MACHINE BAY

Four cupolas for hematite iron having a capacity of 20 tons per hour each of molten metal and one cupola for grey iron having a capacity of 6 tons per hour are situated along one side of the foundry. These cupolas are fed directly from wagons (standing on an adjoining siding or from stock lines), and all charging is done by mechanical means which incorporate controlled automatic weighing and batching.

A new steel foundry, in course of erection, is situated a short distance from the main works. This foundry, which will have an immediate capacity of 60 tons of castings per week, is expected to be ready for production within the next three months. All patterns used in the foundries are supplied by a large modern pattern shop which has been in full production for over eighteen months.

Although they are almost fully equipped, the lay-out of the machine shop and erecting bays is at present of a semi-temporary nature. Two new bays, 480ft long and 60ft wide, now being built at the side of the main building, will be merged into these sections. A comprehensive range of modern machine tools has been installed and although in the main the machines have been selected primarily for the manufacture of mining machinery they are equally suitable for most classes of medium heavy general engineering work.

To supply the numbers of heavy pressings required for conveyors and other mining plant a large press shop has been laid down and equipped with a suitable range of plant, including profile gas cutting machines, automatic welders and heat-treatment furnaces. This department has been in full production for some weeks, and, although at present output is confined to components for mining machinery, a certain amount of the capacity will eventually be available for other classes of similar work.

When the company first embarked upon the

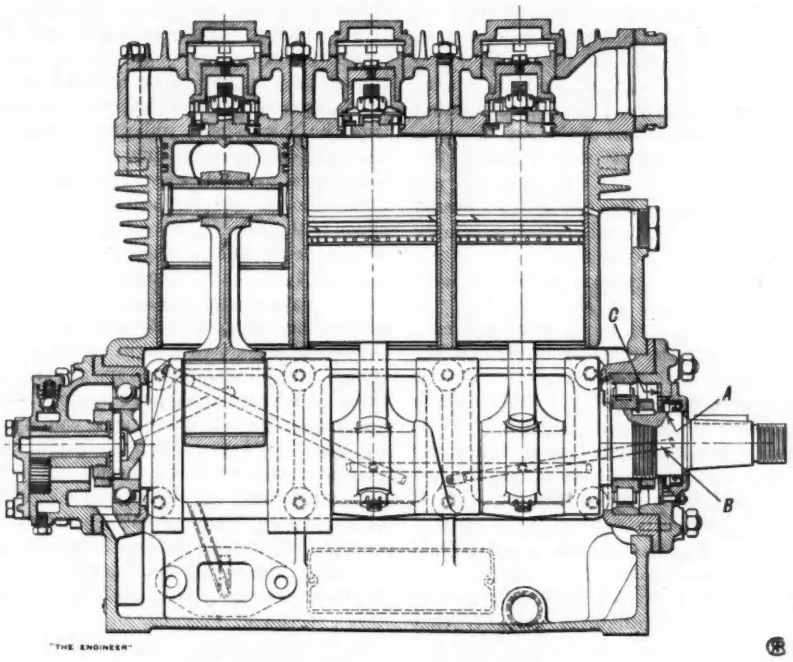
manufacture of mine cars some two years ago it laid down and fully equipped a large fabricating shop. This shop is situated a short distance from the main works and is on the same site as the steel foundry now under construction. As the anticipated demand for mine cars did not materialise the shop has been diverted to the manufacture of a variety of other engineering plant. At the time of our visit a considerable amount of chemical and by-product plant was being fabricated in addition to various component parts for mining machinery. At present some 25 to 30 tons of fabricated work is completed in the shop each week and, when labour becomes available, the output can be doubled. This shop is equipped with modern machines, which include an electric automatic welding machine, plate and angle bending machines, profile burning machines, rotary shearing machines, &c.

A Vacuum Brake Exhauster

THE increasingly exacting conditions of railway traction service require all apparatus to run for long periods without attention and with a minimum of discomfort to the passengers. With vacuum exhausters one point needing very careful attention is the elimination of noise and smell, and the "Westex" exhauster, now being manufactured by the Westinghouse Brake and Signal Company, has been designed to eliminate these undesirable features. The design of this exhauster can be seen in the sectional drawing reproduced herewith, which shows the arrangement of a three-cylinder machine having a swept volume of 72 cubic feet per minute at a speed of 1000 r.p.m.

In this exhauster the vacuum conditions obtaining in the brake pipe of the train are automatically balanced with vacuum conditions existing on both sides of the pistons. Thus the tendency for oil to be drawn past the pistons and discharged through the exhaust is minimised. To produce these conditions it is necessary for the crankcase to be sealed and no breather is permissible. The crankshaft bearing at the drive end of the exhauster is made air and dust-tight by an oil-hydraulic pressure seal A, which imparts an additional advantage, in that the interior of the machine is protected from entry of dust or grit, an important feature on locomotives operating in desert countries. Oil is pressure fed through a drilled hole B in the crankshaft, and by use of a restricted return port C to the sump a moderate pressure of oil is maintained in the space between the oil seal and the ring, thus providing an airtight seal and preventing dust from entering. The approximate equalisation of vacuum on each side of the pistons reduces the power consumption, which for this type of machine is low. The particular exhauster under consideration is designated 3.V.72 by the makers, the first figure specifying the number of cylinders and the last figures the swept volume at 1000 r.p.m.

Although the need for limitation of weight is very important in any machinery to be installed in multiple-unit electric stock, or in railcars, it is equally important that such weight reduction shall not be affected by sacrificing the robustness in construction which is essential for railway duty. The "Westex" exhauster is therefore provided with liberal bearing surfaces and pressure lubrication from a geared oil pump. While a three-cylinder machine, with cranks at 120 deg., possesses a degree of natural balance, to obtain the smoothest possible running it was considered desirable to balance at least 50 per cent of the reciprocating parts, and this in turn brought some problems in crankshaft design.



LONGITUDINAL SECTION THROUGH EXHAUSTER

It has hitherto been the practice of the Westinghouse Brake and Signal Company to use drop-forged crankshafts for electric or motor-driven air compressors or exhausters, and in machines using no more than two cylinders there was usually no serious difficulty in forging the balance weights integral with the shaft. With a three-throw crankshaft and overhung balance weights it was considered that the forging technique necessary would be liable to set up undesirable stresses between the crank pins and webs, and it was decided to fit a "Meehanite" crankshaft in the exhauster.

The principal factor in the reduction of weight in this machine is the use of aluminium alloys for the crankcase (with which the cylinders are cast integral), the crankcase sump and cylinder head. Centrifugally cast iron liners are used for the cylinder bores. Cast iron liners are inserted for housing the ball and roller bearings and special attention has been paid to rigidity in the design of the crankcase. The use of aluminium alloy, in conjunction, of course, with a generous circulation of lubricating oil, has made the new exhausters notably cool in running, and the high conductivity of the aluminium cylinder head and block prevents local hot spots, a fault common to both exhausters and compressors. The weight of the exhauster is low in proportion to its capacity, being no more than 2¼ lb per cubic foot of swept volume. These exhausters have a speed range from 500 to 1200 r.p.m., a speed of 500 to 700 r.p.m. being used for maintaining vacuum in the train pipe against leakage. These speeds are sufficient to maintain vacuum at any required working value within the usual range used on railways, namely, 18in to 25in. It is, of course, assumed that the aggregate amount of leakage in the various train pipe fittings is not more than the usually accepted maximum amount. The higher range of speed from 1000 to 1200 r.p.m. is used intermittently for release of the brake, the actual speed depending upon the speed of release required.

On railways running in mountainous countries the effect of altitude upon the maximum of degree of vacuum that can be maintained is important. Tests have shown that the new exhausters can maintain a vacuum slightly exceeding 90 per cent of the barometric maximum, and satisfactory service can be obtained in countries where there exists the combination of high altitude and the need for operation of extremely long and heavy freight trains. In such circumstances it is usual to work at a lower degree of vacuum than with passenger trains, usually 18in instead of 21in, these figures being based on barometric pressure at sea level. If a line of railway over which very long and heavy freight trains are operated includes an altitude of, say, 3000ft, the same brake power and the same release times as normally obtained at sea level can be obtained at maximum altitude by setting the snifting valves to operate at 16in instead of 18in. In Great Britain, however, the maximum length of fully-fitted freight trains does not exceed the maximum of passenger trains by a sufficient amount to justify a working vacuum different from that normally used on passenger trains.

We are informed that the performance of these exhausters has proved very successful, and in one installation, where two exhausters were mounted in the motor compartment of a railway vehicle, the discharge connections which would ordinarily be piped to the atmosphere were allowed to exhaust into the compartment. During continuous runs of more than two hours under these conditions no smell of oil vapour was noticeable in the compartment.

Harbour Works at New Brunswick

AWARD of a contract for 2,500,000 dollars harbour improvements at Saint John, New Brunswick, has been announced by the Federal Government. The construction, involving the rebuilding of the McLeod-Pettingill wharves and transit sheds on the east side of the harbour, will be carried out by the Saint John Dry Dock Company. The new works, consisting of an enlarged wharf and transit shed, will greatly increase the dock facilities of the harbour of Saint John. The wharf will berth two ocean-going vessels and will give a minimum depth of 35ft at low tide. It will replace the two existing wharves. Specifications call for a steel and concrete structure 873ft in length and extending approximately 55ft farther out into the harbour than the present wharves. The new concrete crib work will be 48ft wide and will be built outside of the old cribs. The new transit shed will have at least three times the accommodation of the two buildings now being used. In addition to the above, it has been announced that the National Harbours Board has plans for a capital and maintenance programme on the Halifax waterfront that will mean the expenditure of more than 3,800,000 dollars. The principal items will be the construction of a concrete pier and two steel transit sheds at Pier Three.

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NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for Publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

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NATIONALISATION AND "SOCIAL DEMOCRACY"

MANY reasons have been advanced by the Government for nationalising industries in this country. In the coal mining industry, for instance, it was claimed, amongst other things, that under private ownership the division of coalfields caused coal which might more economically be brought to a nearby pithead to be actually transported underground uneconomically to a more distant one; that the coal owners had failed to introduce modern methods of mining coal and had failed to adopt mechanisation sufficiently rapidly; that too little attention had been given to working conditions with the result that it was difficult to attract manpower to the industry; and that considerable economies could be effected by shutting down some of the less efficient or more nearly worked out collieries and concentrating expenditure upon others where it might be expected to increase output. Unification of control was expected, in fact, to bring many blessings in its train. But last Sunday Mr. Shinwell, the *enfant terrible* of the Labour Party, let yet another cat out of the socialist bag. As seen by some at least of the socialists the Coal Board is not, it seems, doing all that was expected of it. "Defects are being exposed." The Government, or that part of it of which Mr. Shinwell may be regarded as a spokesman, is at long last learning that "the application of an Act of Parliament does not depend upon the legislators, but on the people who operate the Act," that, in fact, ideological schemes are liable in practice to break down because they have to be operated by and for human beings who are not ideological, and not necessarily even logical.

What was the purpose of nationalising the coal industry? We never held a high opinion of the idea that it was necessary to nationalise in order to encourage modernisation and more economical operation. For those objects could have been obtained in more satisfactory ways. Modernisation of the iron and steel industry, for instance, is being carried out by the industry itself. We might add in parenthesis that as compared with the slow expansion of coal output that of steel is now higher than ever before and might be even higher still but for the failure of the Government to make available promised supplies of scrap. In engineering, whether or no the Government was offering encouragement, the opportunity provided by the sellers' market would have been seized as favourable to the expansion and modernisation of business and the re-equipment of works. For that very profit motive which socialists so much despise provides the incentive towards improving productive methods and expanding output. There is, indeed, no need to nationalise when an industry is its own sharpest critic, as the Reid Report revealed the coal industry to be. Much of the work of the Coal Board, in fact, has proved to be implementation of the recommendations of the Reid Report, recommendations that would have been followed by the industry even if it had not been nationalised. Mr. Shinwell expressed it quite clearly: "Nationalisation simply means a change of mechanism." What, then, was the real purpose of nationalisation? Let us listen again to Mr. Shinwell. "I purposely introduced the principle of consultation within the industry as between the management and the workers. But it doesn't work out so well. . . . What is the real defect in all these schemes? It is that we have not got a real social democratic concept. . . . You can have nationalisation without achieving social success. It is only when there is introduced the element of democracy that there is the possibility of achieving your socialist purpose."

So, according to Mr. Shinwell, it was social democracy, whatever precisely that ideology may be taken to mean in practice, not merely modernisation and re-equipment, that was and presumably still is sought by nationalisation proposals. But what a red herring is this! For whatever changes occur in industry managements must continue to manage and workers must continue to produce. The two functions cannot satisfactorily be fused. The principles of policital democracy are not wholly applicable to the direction of a firm. One of to-day's problems, in fact, is to learn how, whilst keeping their jobs distinct, to bring home to management and men alike the essential unity of their interests, how to generate amongst the men a loyalty and pride in the the firm, instead of fear of the sack, and amongst managements a greater understanding of the needs of men who are often inarticulate and some of whom are hostile. Surely in the evolution of forms of management, suited to an age of full employment in which information, ideas, criticisms and comments can freely pass throughout all sections of a works, the smaller concerns, not the very large ones, are the more likely to lead? For the larger the concern the less easy is it for the directorate to understand the local importance of a seemingly trifling matter and the less easy is it for men to appreciate that their complaints and grumbles are receiving the attention they deem to be their due. The bigger the unit, in fact, the more difficult, not the easier, it is to secure satisfactory industrial relationships, the less easy it becomes to evolve towards some such "social democracy" as that which Mr. Shinwell desires. Nationalisation, we believe, by creating very difficult problems of mere organisation that may themselves take years to solve, hinders rather than helps that evolution.

LOCOMOTIVE VALVE GEARS

DURING nearly a century of locomotive development there have been no particularly outstanding innovations in either the valve or valve gear design that have survived the test of time, though many forms of valve-operating mechanisms have been suggested by numerous inventors, all with the idea of attempting some improvement in the steam distribution. It is only comparatively of late years that serious attempts have been made to introduce poppet type valves, though they might well be expected to show advantages compared with those of the piston type, but here again, while much ingenuity has been displayed by inventors and workable gears evolved, they have as yet had little influence on standard practice, which clings to the older gears, mainly Stephenson's or the Walschaerts arrangements.

Recently we have referred to certain loco motive experiments initiated on what was at the time the L.M.S. Railway, involving a number of locomotives, all of the same basic design, but differing in the type of valve gear fitted. Of these, some have a poppet valve application, including a rotating cam operating gear; others have Walschaerts' well-known valve gear with conventional piston-type valves, and one engine is fitted with the oldest of all locomotive valve gears capable of both reversing the motion of the engine and providing means for expansive working—Stephenson's curved link gear. Interesting as this experiment may be, the question can well be asked, what is expected to be learnt from these gear applications, all of which are well known? There are, for instance, far more locomotives now running fitted with Stephenson's gear than any other, while for some years past now the Walschaerts gear has been increasingly used; in fact, it appears to have become well nigh standard practice. Poppet valve gears have also received considerable attention during the last few years, and have, moreover, already been the subject of numerous experiments. Some light has been thrown on the subject by Mr. E. S. Cox in his paper on the development of L.M.S. locomotives, read before the Institution of Locomotive Engineers in 1946, in which it is stated that "Stephenson and Walschaerts gears have proved themselves very reliable, and low in maintenance cost, but their lubrication consumes a good deal of oil and manhours." Referring to rotary cam gears, it is stated that they give "no

particular mechanical troubles," and, later, the opinion is expressed that "the freedom from wear and ease in servicing which a well-designed, fully oiled, sealed rotary drive should be able to offer is an objective worth striving after." This may explain why a further application of a rotary cam gear that has already been tried is now being made and, incidentally, indicates how right Mr. Bulleid was when he fitted his "Merchant Navy" class and other "Pacific" type engines with an enclosed self-lubricating adaptation of the Walschaerts gear. Whether or not Mr. Bulleid's gear is readily adaptable to locomotive requirements in general may be a debatable point, but it should not be beyond the ingenuity of designers versed in locomotive engineering to evolve a totally enclosed valve gear of a relatively simple link-type that would meet the requirements postulated.

On the subject of valves of the piston and poppet types, according to trials already made, it would appear that the only difference of note is the fact that when judged over a period of time—six years—the latter show to some advantage, for, in this connection, Mr. Cox informs us that in fuel consumption over the period an economy of from 5 to 6·5 per cent is shown, which "certainly seems to point to a better average steam tightness." Judged from the foregoing, it is very evident that the "pros and cons" of the different types of valve gear with which the new engines have been equipped have already been carefully investigated; we therefore look forward to hearing the outcome of these later experiments. Keeping in mind the advantages expected from enclosed gears, the outside application of Stephenson's gear now being tried would seem to have little to recommend it save only from the point of view of accessibility. No doubt this is an important practical consideration; even so, it seems probable that the inside application, as followed for about fifty years on the Great Western, may well prove the most desirable, for there has never been any difficulty in operating a long-travel valve gear by means of eccentrics. This has been amply proved by past practice in the United States and was fully realised by Mr. G. J. Churchward when he designed the Stephenson gear, which is still standard on the (G.W.R.) Western Region, British Railways.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

PNEUMATIC TYRES

SIR,—For accurate future reference to the invention of the pneumatic tyre by my father, John Boyd Dunlop, may I, in no quarrelsome spirit, correct several errors made in one or two quarters during the recent Diamond Jubilee of that event?

The statement that my father tested his first tyre by filling it with water is nonsense; anyone stupid enough to do that could never have invented a pneumatic tyre. Nor was the first tyre tried out in a Belfast "backyard." These first experiments were made in our long veterinary yard, the little wheels being rolled up to the large wooden gate, when it was closed for the night.

I remember my father's gigs and many a long drive I had in them seated on a tiny "boss" (or cushion) at his feet. There was room on the seat for him and the groom only. It has been said that my father had no knowledge of mechanics. My own opinion is that he was born with the knowledge. No one, at any rate, will deny his resourcefulness, applying to the making of his first tyre the knowledge gained in making his own veterinary rubber gloves and securing the tyre to its wooden disc with a strip from an old linen dress of my mother's. I was with my mother in the grandstand at Belfast College Sports when William Hume won all four bicycle contests, and I shall never forget the excitement as the first pneumatic-tyred "safety" crept up to the leading riders and eventually passed them.

My father never thought of using a hose-pipe. Attached is his own comment on that story.

"The garden hosepipe story is childish—the material is so inelastic that it would be incomparably slower than a solid tyre. It could not be ridden on the road for 100 yards without being cut to pieces, and I should deem it impossible for an amateur to make an inner tube small enough to be drawn into the hose pipe—not to mention the inserting of a valve. The internal diameter of a hosepipe would be about equal to the diameter of one's little finger."

JEAN W. MCCLINTOCK

Eastbourne, April 30.

An Empire Trade Policy

A DINNER, organised by the Empire Industries Association and British Empire League, was held at the Savoy Hotel, London, on Tuesday evening last, and was attended by a large company representing many sections of British industry. Lord Lyle of Westbourne was in the chair, and the principal guest and speaker was the Right Hon. L. S. Amery, C.H., President of the Association, who announced the launching of a nation-wide campaign in support of the expansion of Empire trade.

In his speech Mr. Amery said that the present crisis went back, in a sense, to that "springtide of economic frenzy," to use Disraeli's phrase, in which a century ago we abandoned all control over our economic life, all idea of a balanced economy at home, all thought of developing our own Empire, or even of securing ourselves by reasonable reciprocal bargains with other countries. Dealing with the inter-war years, he recalled the steps taken at the Ottawa Conference, following the financial crisis of 1931, to build up an Empire economic system, and asserted that nothing except a bold, wholehearted development of the policy begun at Ottawa could give this country any hope of real expansion or of replacing the unearned income sacrificed in the recent war. To make good the loss that had been suffered meant an increase of 75 per cent in the volume of our pre-war exports, or, actually, in view of the shrinkage of coal exports, an increase of at the very least 100 per cent in our exports of manufactures. Only the most incredible ignorance of the trend of world economics, Mr. Amery declared, could have led anyone to dream that such a target could ever be reached without our only real stand-by, a policy of Empire expansion. The Chancellor of the Exchequer, he continued, had made it clear that, even with Marshall Aid, we should only scrape through this year by cutting down the reserves of the sterling area to the absolute minimum, and on condition that the revised export target of 150 per cent of 1938 was reached by the end of the year. It was already clear, Mr. Amery thought, that the revised target would not be reached and that fresh restrictions and reductions in our standard of living would have to be imposed before the year was over.

Mr. Amery went on to ask, amongst other questions, how we could hold our own as exporters if we had no expanding home market, how we could compete in efficiency with rivals if we were forbidden to re-equip our factories, and how we could expect enterprise and efficiency if risk was allowed no compensating profit and if the best professional brains were deprived of their reward. What was needed, he urged, was a complete reversal of policy; not a policy of exports for exports' sake, in a world of indiscriminate competition, but a constructive policy of development and productive expansion which would bring the necessary expansion of exports in its train. The material condition, the resources for such a policy, were there, above all, in the Empire.

The Government's schemes of Colonial development, its negotiations with Dominion Governments, and its discussions with our European neighbours were, Mr. Amery agreed, in the right direction so far as they went. But they could not be really effective if they were treated as emergency makeshifts, destined to make way at the earliest possible opportunity for the directly contrary policy to which we had subscribed at Geneva and at Havana. The Empire could not be treated as a stop-gap to be thrown overboard at convenience. Empire preferences, Mr. Amery emphasised, could only achieve their results in increased production if those whose capital and effort were to create that production knew that the future was assured. An Empire policy was a policy of priority in finance, of restoring sterling to its old pre-eminence, of priority in shipping and aviation, and of migration. It was an indivisible whole which must be carried out as such, and was a policy, not for a year or two, but for a century ahead. Only thus, Mr. Amery concluded, could it appeal to people here and overseas. Only thus could their energy and enterprise be liberated and their defeatism and despair be replaced by hope and determination.

Literature

SHORT NOTICES

Art and the Industrial Revolution. By Francis D. Klingender. London: Noel Carrington. 1947. Price 21s.—This is a very pleasant book, printed in a large type on good paper. There are many illustrations, some in colours. The author wanders over a hundred subjects, sometimes discussing a picture, sometimes an artist, sometimes presenting views of the social conditions of England in that epoch which carries the name of the Industrial Revolution. He shows throughout astonishing industry in the collection of material and presents it admirably with many quotations from the poets, and excerpts from contemporary prose literature. Where he deals with technical details he does so discreetly and correctly. That he is an admirer of Samuel Smiles is evident. The choice is well made, for with all his little faults and inaccuracies Smiles wrote a series of biographies which of their kind are unsurpassed. We ought perhaps to warn the would-be reader that with the exception of familiar pictures, like Bourne's famous railway views, the illustrations selected by the author throw very little light upon the industries of the period.

BOOKS RECEIVED

Aircraft Welding. By Rollen H. Drake. London: Macmillan and Co., Ltd., St. Martin's Street, W.C.2. Price 20s.

New Views on Apprenticeship. By W. McLaine. London: Staples Press, Ltd., Cavendish Place, W.1. Price 10s. 6d.

The Efficient Use of Steam. By Oliver Lyle. London: His Majesty's Stationery Office, Kingsway, W.C.2. Price 15s.

Machine Shop Companion. Eleventh edition. London: Bentley Publishing Company, 21, Bedford Street, W.C.2. Price 2s. 6d.

Aircraft Sheet Metal. By Rollen H. Drake. London: Macmillan and Co., Ltd., St. Martin's Street, W.C.2. Price 27s. 6d.

Chemical and Electro-Plated Finishes. By H. Silman. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 30s.

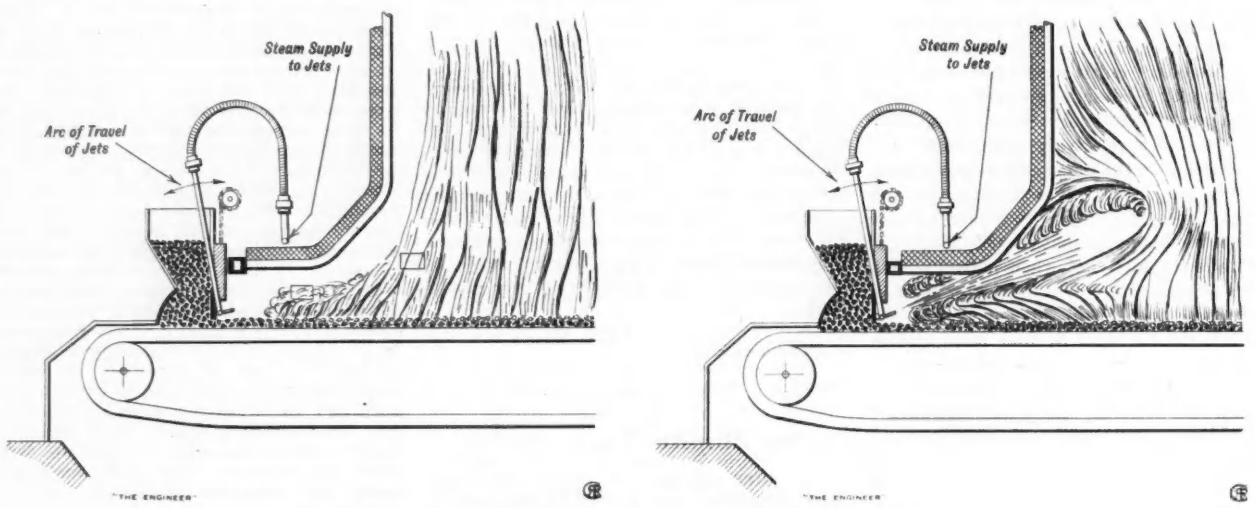
Ignition Jet System for Boilers

MUCH trouble has recently been caused in boiler plants by the use of coal of grades inferior to those for which the boiler was designed. As a consequence it has often been necessary to run boilers below their ratings. Recently there has been developed by Courtaulds, Ltd., a means whereby the combustion of low-grade and fractious fuels on chain-grate stokers can be improved. It has not yet been fully determined what effect the system has upon the efficiency of a boiler fitted with it. But by the use of the system the output of a boiler using inferior fuel can, it has been demonstrated, be much improved, whilst tests have shown the percentage of CO_2 in the flue gases to be very appreciably increased. Evaporative gains exceeding 50 per cent have been recorded.

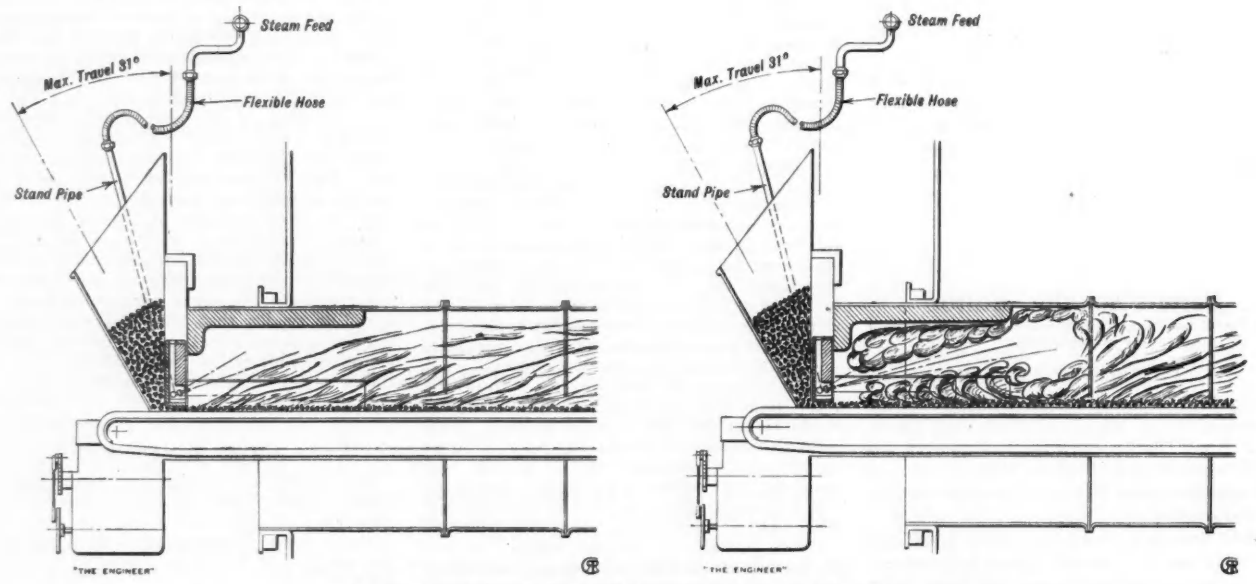
The principle is shown in accompanying drawings, Figs. 1 to 4. A number of steam jet nozzles are mounted in a steam supply bus line, which is arranged on the lower end of the coal feed regulating shutter of the stoker. In this position the nozzles always retain the same position relative to the fire bed whatever the rate of firing. The bus-pipe is mounted in trunnions so that the jets projected by the nozzles can emerge horizontally or at any angle up to about 15 deg. above the horizontal, according to choice. In a typical installation on a 50,000 lb per hour water-tube boiler with a 14ft grate there would be forty-four nozzles, of which thirty, $\frac{1}{16}$in diameter over the central portion of the bed, would be placed at 3in centres and, at each wing, seven of $\frac{1}{8}$in diameter would be placed at 4in centres. For a Lancashire boiler five $\frac{1}{4}$in diameter nozzles might be placed over each furnace. The steam pressure to be used would vary between 15 lb and 50 lb per square inch and the total steam consumption would lie in the region of 1 per cent of the boiler output. The accompanying drawings indicate the effect upon combustion of turning on the jets.

The operation of the jets causes a vacuum over the front portion of the fuel bed, whereby air and gases from this area are entrained by the high velocity of the steam and projected into the volume of burning gases above the active bed further back on the grate. The jet loses its identity here, turbulence and admixture with the hot gases resulting. The hot burning gases flow back to fill up the vacuum caused by the jet of steam. They do so on a well-defined path, those below the jet making direct contact with the surface of the incoming fuel and giving immediate ignition, whilst those above the jet tend to increase the temperature of the ignition arch and thus further promote ignition of the fuel by radiation. Variation of the steam pressure to the jets varies the extent to which the hot gases are drawn back towards the guillotine. The extent and accuracy of this control has been found to be very fine and a straight-line ignition across the grate can be accomplished.

We are informed that on the installations developed at the various works of Courtaulds, Ltd., where the output from boilers has been downrated as much as 30 to 40 per cent through the use of low-grade fuels, the operation of the system allows full boiler rating to be attained using the same fuels. This marked improve-



FIGS. 1 AND 2—WATER TUBE BOILERS—JETS OFF AND JETS ON



FIGS. 3 AND 4—LANCASHIRE BOILER—JETS OFF AND JETS ON

ment is believed to be due to early and sustained ignition of the fuel, which increases the effective grate area and also materially assists complete combustion.

Accompanying drawings show a typical jet nozzle, Fig. 5; the trunnion mounting for the steam bus-pipe, Fig. 6; and a mechanism for rotating the bus-pipe, Fig. 7. Figures tabulated herewith indicate some results obtained in tests by Courtaulds, Ltd., on Lancashire and water-tube boilers using various fuels.

In a very public-spirited manner Courtaulds, Ltd., has agreed that the manufacture of this device in the United Kingdom and the Isle of Man, and its use within that area, will be free to anyone on the sole condition that the device shall bear the marking "Courtaulds, Ltd., Patent Application No. 23,985/47." The right of export of the device or of manufacture or use of it overseas and of the exploitation of the patents covering it has been invested in Babcock and Wilcox, Ltd.

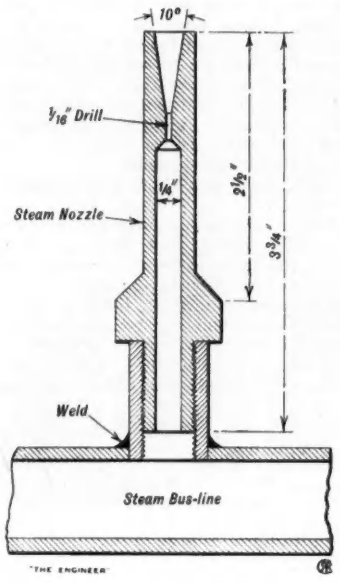


FIG. 5—TYPICAL NOZZLE

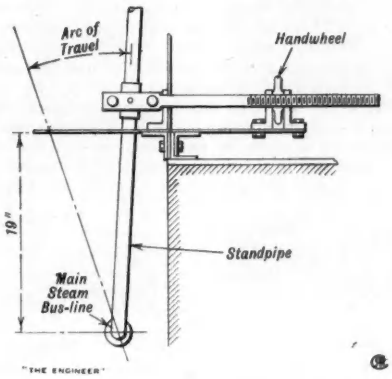


FIG. 7—ADJUSTING MECHANISM FOR BUS-PIPE

Results Obtained when Firing Various Fuel Mixtures on Lancashire and Water-tube Boilers

Class of fuel	Gross calorific value	Jets off			Jets on			Evap. gain, per cent.
		Evap.	CO_2	Wind box air pressure	Evap.	CO_2	Wind box air pressure	
Lancashire boilers (10,000 lb per hour evap. normal):								
(1) Low-graded reclaimed Guy Pitts mound slack	7,119	3,610	8·65	0·93	5,710	12·4	0·89	57
(2) Up-graded reclaimed Guy Pitts mound slack	8,666	7,530	10·6	2·3	10,740	11·7	2·5	43
(3) Manvers main silt (3mm size)	8,697	—	—	—	4,800	7·6	2·6	—
(4) Manvers main silt 30 per cent, Bituminous slack 70 per cent	9,553	—	—	—	7,700	—	—	—
Water-tube Boilers (60,000 lb per hour normal):								
(5) Low-graded reclaimed Guy Pitts mound slack	7,525	—	—	—	50,725	—	—	—
(6) Manvers main silt 30 per cent, American run-of-mine 70 per cent	11,384	—	—	—	40,000	—	—	—
(7) Crushed Johnnies 25 per cent... Cannel ... Manvers silt 25 per cent ... American run-of-mine 50 per cent	12,564	—	—	—	33,000	—	—	—
(8) Crushed Johnnies 50 per cent... Manvers main silt 50 per cent...	11,004	—	—	—	20,000	—	—	—

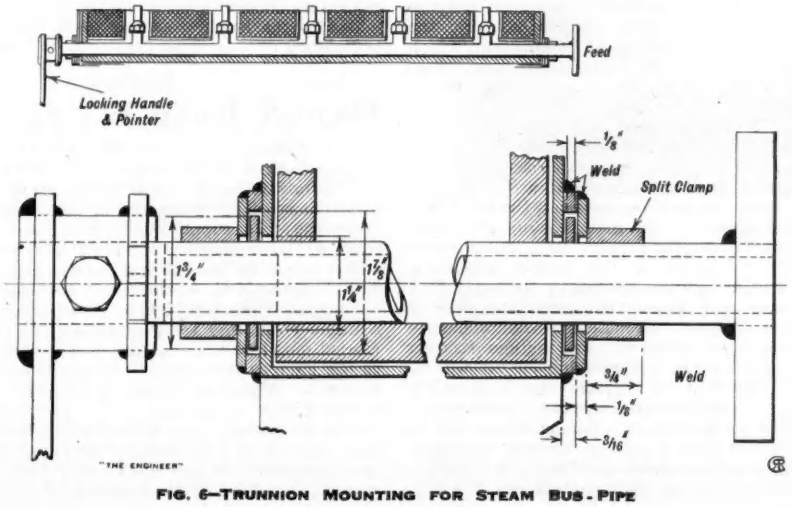


FIG. 6—TRUNNION MOUNTING FOR STEAM BUS-PIPE

The British Institute of Management

THE British Institute of Management was officially opened at a meeting in London on April 24th. Reference to the event was made in a leading article in our last issue, and in what follows we give some information about membership of the Institute. The hope is expressed that all who join will do so with the desire to contribute to the Institute's work rather than with the object of seeking what they can themselves immediately obtain from it. Eventually, it is intended to establish grades of membership based on professional qualifications.

Until such time as these membership grades have been established, and in order to constitute a body of people to control the Institute's affairs through the exercise of voting rights, a limited number of persons, carrying substantial responsibility in general management and public administration, are to be appointed as Founders of the Institute. They will subscribe five guineas a year, and will enjoy the rights and privileges of members, apart from the right to use letters of qualification after their names. Provision is also made for individual subscribers, and any person interested in management may join the Institute under this classification on payment of three guineas a year. Although they will enjoy most of the services of the Institute, individual subscribers will have no voting rights, and they may not represent themselves as qualified members. Firms, public corporations, and other organisations are invited to become corporate subscribers to the Institute. Corporate subscribers will be asked to co-operate in the work of building up the body of knowledge on management, by providing facilities for research and investigation, giving information about their current practices and procedures, and participating in conferences.

Another matter of interest is that the Institute is exploring with existing organisations the possibilities of co-operation and the elimination of duplication of effort, and it intends to invite bodies, whose general purpose is the promotion of higher standards of management, to co-operate with it in such specific tasks as the compilation and presentation of management knowledge. It is realised, of course, that variation in the scope and character of existing organisations and some overlapping of functions make it difficult, and probably premature, to devise a scheme of general application.

Finally, the Institute intends to encourage local initiative and co-operation in stimulating interest in the study of management. With that end in view, rather than establish its own local branches, the Institute will welcome the formation of local management associations, bringing together all those who are interested in management questions. Such associations, it is envisaged, would be left entirely free to manage their own affairs, including finance, but the Institute would be ready to give advice and assistance if required. It is suggested that local branches of existing management organisations, while retaining their identities, would welcome the opportunities for co-operation created by these proposed local management associations. Provided that a local management association was soundly established and was willing to subscribe to a charter of general principles, the Institute would be prepared to grant it the status of an affiliated organisation. This would mean that in return for a capitation fee on its membership, a local management association would have the right to call on certain central services provided by the Institute. The Institute is convinced that local associations, if generally established, would prove to be a most potent factor in spreading interest in the development of management, and it would be glad to hear from groups of managers who might be interested in forming associations in their own localities.

The headquarters of the British Institute of Management are at 17, Hill Street, Berkeley Square, London, W.1, and Mr. L. O. Russell is the Director.

Earth Leakage Control Panel

IN co-operation with H.M. Inspector of Factories the Igranic Company, Ltd., of Bedford, has evolved a safety control panel which is specifically suitable for shipyard use where a.c. supplies are taken by cables from the quayside for working on board ship. This panel is designed to safeguard welders and others using electrical equipment on the ship by ensuring earth continuity and by switching off the a.c. shore supply unless the earthing is adequate. In the absence of any such safeguard accidents have occurred when "shore-based" supplies have been used to feed apparatus on board at the normal 400/440V, three phase, 50 cycles per second. Consequently, there has been a tendency to transform the supply to a "safe" voltage on the quayside and to run the required number of welding leads from the quay to the vessel. This arrangement causes severe crowding of cables on deck and interferes with the progress of other work. Furthermore, the operation of connecting up and disconnecting at the conclusion of work involves a good deal of unnecessary delay.

These disadvantages are eliminated by using a single cable with the Igranic earth leakage control panel to bring an a.c. supply at normal voltage to a central distribution point on the vessel. The system has been applied with striking success at the Scotstoun shipbuilding yard of Charles Connell and Co., Ltd., which finds that a ship can be connected through the panel to the quayside supply point in half an hour instead of the three to four hours previously needed. When fitting out in Glasgow harbour, for instance, it is claimed that the cost of the panel is offset by the working time saved on four ships.

Using the earth leakage control panel the installation consists of five parts: (1) an a.c. shore supply at normal voltage, (2) an Igranic protective cubicle usually mounted on the quayside next to the ship it is feeding, (3) a distribution centre, (4) an Igranic master control unit housed in the ship, and (5) a three-core and earth flexible cable from the protective cubicle to the distribution centre. The photograph reproduced herewith shows the protective cubicle on the left and the master control unit (providing manual control of the a.c. supply on the ship) on the right.

To allow a standard cable to be used the armouring of the cable is used for earthing. Referring to the accompanying diagram, the three main cores L_1, L_2 and L_3 of the cable carry the power supply. The fourth core, which normally would be used for earthing, is used in the present instance as a pilot wire to provide a return path for the circulating current which flows through the rectifier, the armouring and the resistance A B. As explained more fully below, this circulating current forms an essential part of the protective system. The cable plug and socket terminations are fitted with a fourth main pin connected to the armouring so as to ensure continuity for the low-voltage circulating current. The subsidiary pin which is normally used for the earth circuit is connected in this instance to the pilot core.

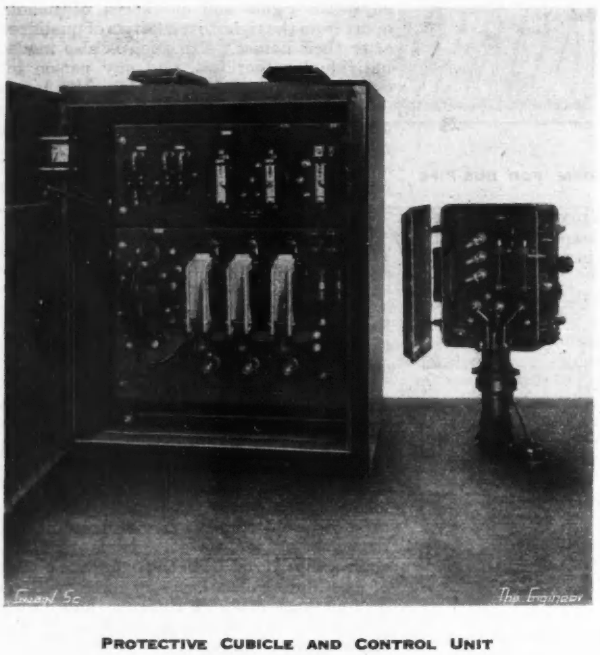
The panel gives two-fold protection. First, earth leakage protection is provided by the usual vectorial balance of the secondary coils of three current transformers energised by the main supply. Any fault or damage to the cable resulting in earth leakage of more than 15 per cent actuates the relay E L R shown in the diagram and opens the main contactor M. Secondly, the panel gives protection against certain other kinds of cable and continuity faults in the earth circuit. For this purpose the panel incorporates relays which trip the power supply in the event of any fault which causes the circulating current to vary from its normal value by more than a predetermined amount.

For example, referring to the diagram, i the cable is spiked, causing the earthed armour to make contact with the pilot core, thus short circuiting the limiting resistance A B, the circulating current increases and the relay R B operates, causing the main contactor to open and disconnect the supply. If a break occurs in the pilot core or the flexible armouring the circulating current ceases, the relay R A operates and again the main contactor is opened. Since the circulating current emanates from a transformer-fed low-voltage rectifier a minor fault in the earthing circuit will be quite sufficient to operate the appropriate relay and shut down the supply to the ship. It will be noted that by opening the switch in the master control unit on the ship the circulating current is interrupted and the supply is switched off by the main contactors.

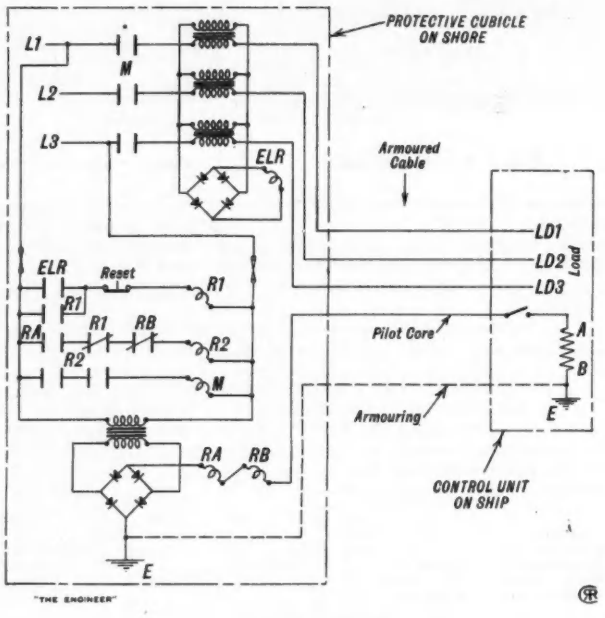
Referring to the protective cubicle as illustrated herewith, the earth fault and circuit continuity relays are mounted on the upper panel, below which is the main triple-pole contactor. A reset push button for use after the earth leakage relay has operated is flush fitted in the door and the back connections for this push button can be seen towards the top left hand of the illustration. This particular panel was supplied without an isolating switch, but the maker recommends that all future units should be supplied with a triple-pole isolating switch built into the cubicle for interlocking with the control gear, both mechanically and electrically.

Referring to the photograph reproduced, the small control unit on the right is fitted to the steel cradle which usually houses the distribution gear on the ship. The plug and socket for connection between the cable and the control unit can be seen attached to the bottom of the enclosure.

It is usually convenient to mount the protective cubicle on a wheeled truck and, although the illustration does not show it, this unit was actually so supplied. The cubicle is made in ratings of 150A and 300A. Smaller ratings can be supplied, but are discouraged on the grounds that increased demand for a.c. service in ship construction is likely to require smaller units to be superseded by larger ones. The approximate dimensions of the 300A cubicle would be 4ft high by 3ft wide by 2ft deep (including isolator) with approximately 1ft added to the height to allow for a truck for portability.



PROTECTIVE CUBICLE AND CONTROL UNIT

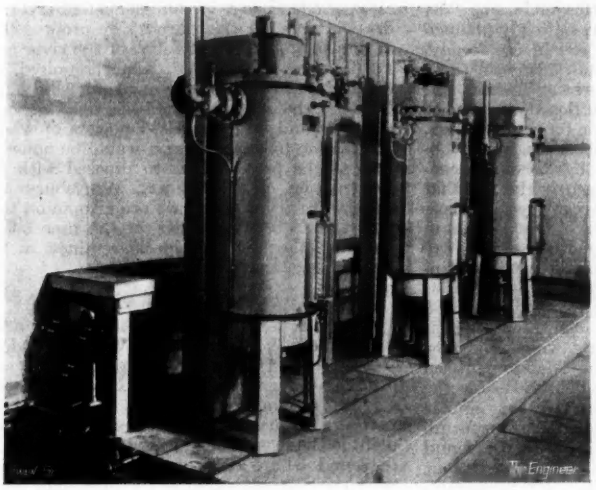


KEY DIAGRAM

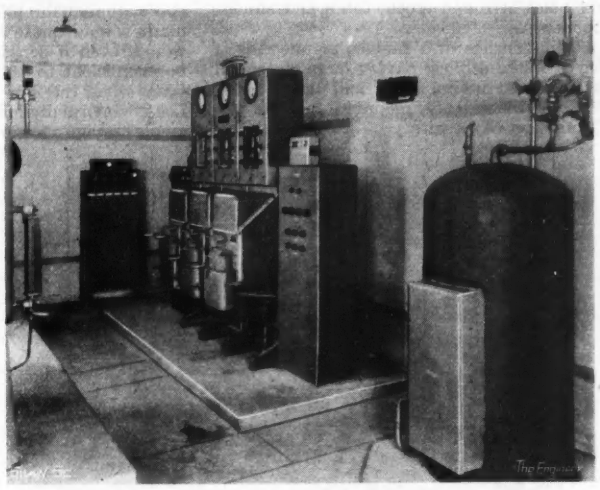
Electrode Boilers in a Factory

THE suitability of electrode boilers for steam raising or hot water heating in industrial establishments and canteens is well exemplified in a Glasgow factory engaged in wire weaving, where the steam supply was obtained originally from a "Lancashire" boiler, in addition to which a sectional hot water boiler was installed. The time arrived when this "Lancashire" cylindrical boiler was due to be replaced and a number of other reorganisations had to be carried out, including the provision, according to the Factory Act, 1937, of adequate canteen facilities. When completed, the reorganisation included the installation of three 350kW electrode boilers (as illustrated herewith), each capable of generating 1000 lb of steam per hour at 120 lb per square inch maximum pressure, supplied by Bastian and Allen, Ltd.,

11, Bedford Square, London, W.C.1. These electrode boilers supply steam for heating the factory by unit heaters, while meeting the steam requirements and the heating for the canteen and kitchen.



THREE 350KW ELECTRODE STEAM BOILERS



SWITCHGEAR FOR THREE ELECTRODE STEAM BOILERS

In general, electrode steam boilers of this make, vertical and cylindrical in shape, of solid drawn steel, are available in standard sizes within the range of 25kW–1000kW. They are fed from supply mains at 346V–440V, 3-phase, 50-cycles, and evaporate 73 lb–3000 lb of water per hour. The average performance figure of approximately 3 lb of water per kWh, varies slightly within the range of, say, 2·85 lb–3·30 lb, according to the inlet temperature of the feed water and the steam pressure. Working pressure also is up to 120 lb per square inch gauge (250 lb test pressure), whilst almost completely automatic operation is given.

Typically, the boiler has a dished bottom and bolted flat top cover, and is carried on four channel iron legs, whilst the three electrodes (one per phase) of cast iron plate wrapped to form a cylinder, dipping into the water, are suspended from the cover by heavy porcelain bushings. In addition, the boiler is insulated with 2in magnesia-asbestos blocks in an outer casing of planished steel, having stainless steel bands and screws.

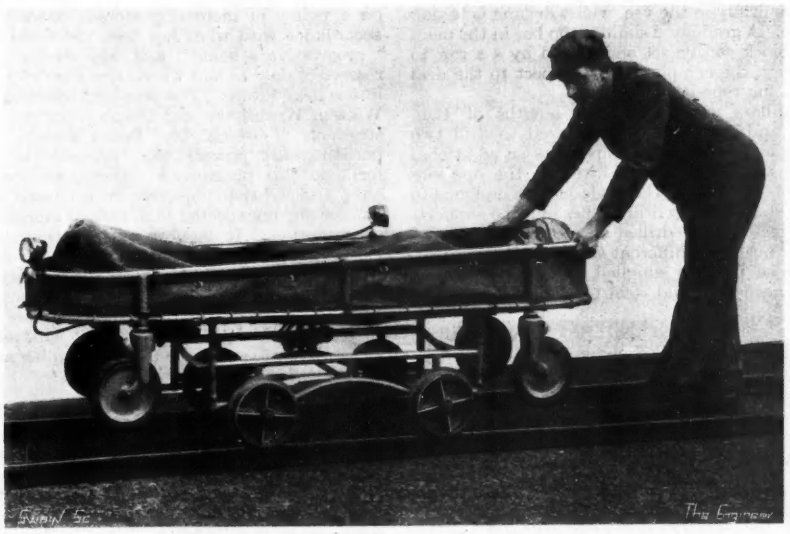
Mountings and auxiliaries are included to form a complete self-contained installation. The boiler feed pump is a single-acting, ram pump, coupled to a totally enclosed electric motor through an enclosed oil-immersion gear mounted on a common bedplate. The pump motor varies in size from ¼ h.p. for the 30kW boiler, to 1½ h.p. for the 1000kW boiler. A wall-mounted control panel incorporates a 6in dial ammeter, an automatic adjustable load control relay, a starter for the feed pump motor, with overload protection in addition to fuses.

In the particular factory installation described and illustrated here, the three boilers, together with condensate pumps and feed pumps, are housed in the same boiler room, two views of which are reproduced herewith to show the boilers and control gear respectively. Normally the equipment is operated with two of the boilers used for heating the buildings while the third boiler provides the kitchen steam supply. All the boilers, however, are interchangeable. A substation is installed on the factory premises to provide a 440V supply.

For the general hot water supply serving the kitchen, cloakrooms, &c., two Bastian and Allen thermal storage electric water heaters are used, one in the boiler house and one in the kitchen. The former has a 3kW and a 6kW heater, the capacity being 100 gallons heated to 160 deg. Fah. as maintained by an automatic mixing valve. The complete plant has now been operating for over twelve months, resulting—quite apart from the convenience—in a considerable saving in space, in addition to a further substantial saving by reduced insurance and maintenance costs, and reduced labour.

A Mine Casualty Stretcher

In order to eliminate many of the difficulties involved in transporting casualties from the coal face to the surface in collieries, the ambulance trolley and stretcher shown in the accompany illustration has been introduced by Siebe, Gorman and Co., Ltd., Davis Road, Tolworth, Surrey. When handling casualties below ground with the normal stretcher methods, not only is a heavy strain imposed on the bearers, but there is often a considerable degree of discomfort to the patient, which in certain cases adds to the injuries already received. With this new equipment, known as the "Riley" ambulance trolley and stretcher, patients are moved quickly with the least possible degree of disturbance by using the rails normally laid along the roadways for the pit tubs.



MINE CASUALTY STRETCHER

The equipment consists of three main components: a canvas carrier in which the patient is first placed, a rail trolley and a wheeled stretcher.

The trolley is of light fabricated steel tubing and is mounted on four flanged wheels, which can be supplied to suit any rail gauge. Four stretcher retaining clips are mounted on coil springs which prevent the transmission of vibration to the stretcher as the trolley passes over rail joints, points, &c.

The stretcher is also fabricated from light steel tubing and is built to form a convenient draught-proof canvas-lined cradle, on which the patient in the canvas carrier is placed. Four independently sprung rubber-tyred wheels on the stretcher enable it to be wheeled on a reasonably smooth surface without fatiguing the bearers. To facilitate the work of the first-aid men and bearers battery fed cap lamps are fitted to the foot of the stretcher and at a convenient place on the side for inspecting the patient.

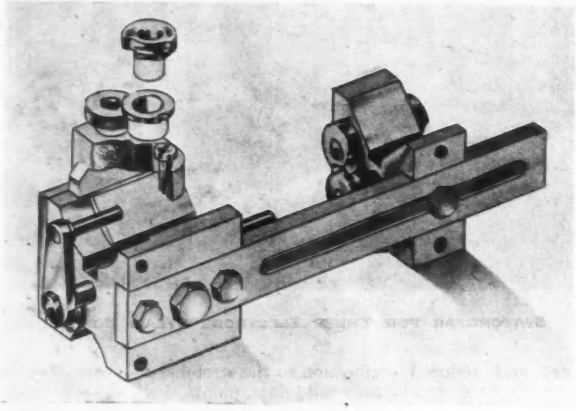
The small overall height of the trolley and stretcher—23in—enables the equipment to be used with ease where there is only restricted headroom. The whole assembly only weighs about 110 lb, the trolley weighing 48 lb and the stretcher 62 lb.

Coil Spring Research Organisation.—The Coil Spring Federation and its Research Organisation are to hold their annual meetings at the Queen's Hotel, Birmingham, on Wednesday next, May 12th. Following the routine business, a lecture on "The Prestressing of Springs with Special Reference to the Internal Stresses Induced," will be delivered at 2.30 p.m. by Dr. J. A. Pope. A discussion will follow.

A Drill Jig

We illustrate below a jig which has been introduced by S. H. Bridson, Ltd., of Bristol, in order to simplify and speed the drilling of radial holes in round stock, tubes and similar components.

This jig consists of a tie-bar, at one end of which is bolted a block having large and small vees machined in its upper and lower faces, respectively. Slidably mounted on the tie-bar is another block with vees of corresponding sizes cut in its upper and lower faces. This second block can be set at any required position along the bar to support the outer end of workpieces, being drilled on the main block. An angle-plate mounted in a slideway at the back of the main block has its overhanging arm bored to accommodate a drill bush with its hole set centrally over the vee. This angle-plate can be reversed in its slideway to register the bush over either the large or the small vees on the block, according to the diameter of the work which is to be drilled. The plate incorporates a clamping screw with a knurled nut, and it can be screwed down to hold work-pieces firmly in the vee, whilst drilling is taking place. A graduated sliding stop bar in the main vee block can be set and locked by a screw to position the components in respect to the drill bush for repetitive working.



DRILL JIG

Tie-bars are available in lengths of 12in, 18in and 24in. If it is required to drill two holes in a number of components an additional large vee-block can be fitted to the opposite end of the tie-bar. The angle-plate is designed to take standard slip drill bushes and the supporting vee-block is drilled to store a number of these bushes of different sizes.

These jigs are supplied in two types, with case-hardened mild steel blocks, and with cast iron blocks.

We are informed that Brooks and Walker, Ltd., 41, Dockhead, London, S.E.1, have been appointed concessionnaires for the sale of these jigs.

Water Supply of London*

The total demand for water depends on population, the needs of industry and their combined rate of consumption per head per day. Although it is difficult to predict with accuracy what the population in the Metropolitan Water Board's area will be in the years to come, or to what figures the combined consumption per head per day will rise, an indication of future requirements can be gauged from the trend of the increasing consumption year by year, and by using this trend adjusted to present-day circumstances an approximate estimate of future demands can be made.

The circumstances referred to are the unprecedented rate of increase in consumption during the past two years and the anticipated continuance of such a large rate of increase so long as rehousing continues, with the extension of modern sanitary equipment and the general improvement in ablution habits and living conditions. We consider that the provision hitherto contemplated for meeting this increasing demand is inadequate and works already planned would, even if constructed and in use to-day, be insufficient to satisfy requirements in those years when the flow in the rivers Thames and Lee is abnormally low. The Board already has ample storage accommodation for normal years.

Moreover, the problem has become accentuated by the fact that in recent years there have been periods of two successive dry summers with an intervening dry winter, that is to say, a period of eighteen months during which the flow in the Thames has been considerably below the average. On similar occasions at some future date it may be found impossible, without special powers, to refill reservoirs after their depletion during the first dry summer. Consequently, it is necessary either to provide storage additional to that hitherto envisaged in order to ensure that adequate storage is available for the second dry summer, or to make special arrangements to replenish reservoirs to their maximum capacity during the dry winter.

Abandonment of "Progressive Scheme"

The time, therefore, has now arrived for the Board to review the programme for the provision of future sources of supply by taking a general conspectus of all practicable sources available, and to adopt a comprehensive plan which will safeguard the present supply and enable future demands to be met for some years to come.

In 1907 and again in 1910 the Board decided on a policy of increasing storage capacity in accordance with what has been described as a "progressive scheme" and constructing new reservoirs only as and when they were required in the near future. The proposed reservoirs at Walton, Wraysbury and Datchet, for the construction of which the Board already has parliamentary powers, were intended to conform to this progressive scheme, and would have satisfied that objective for a limited time but for the unexpected high rate of increase in consumption. It is now evident that these reservoirs will be inadequate, and as no other reservoir sites are available in the vicinity we consider it advisable to depart from the principle of the progressive scheme altogether and to plan for sources of supply that will, as far as can be foreseen, solve the problem for many years.

New Reservoir and Increased Thames Abstraction

Having considered in detail several alternative suggestions, we have come to the conclusion that the most economical and practical proposal would be to construct an impounding reservoir in the Enborne Valley, a few miles south-west of Reading, connected by conduits to an intake and pumping station on the Thames at Pangbourne. The water would be pumped in to the reservoir from Pangbourne and flow back again along the same conduits into the river when the flow of the river at the Board's present intakes is insufficient to maintain the supply without unduly depleting the existing reservoirs. The Enborne reservoir would cover an area of approximately 9 square miles and would provide more than three times the combined capacity of the proposed reservoirs at Walton, Wraysbury and Datchet at less than their total cost. The provision of this reservoir alone would safeguard the Board against any foreseeable increase in the supply provided that at a certain stage in the increasing demand—which is unlikely to occur for many years—special arrangements were available to refill the Board's reservoirs if necessary, during those rare periods when a dry summer is followed by a dry winter. For this purpose we propose that during such a winter the flow of the river over Teddington weir should, when required, be reduced during the winter months.

With the construction of the Enborne reservoir and with increased powers of winter abstraction from the river it would be unnecessary at the present time to proceed with the construction of the Walton, Wraysbury and Datchet reservoirs, and we are of opinion that they should be abandoned for the time being, but that the land should be retained in the ownership of the Board.

Thames Supply to the Lee Valley

We have on several occasions reported on the unsatisfactory yield of the River Lee, and on the effect on the flow of that river of the construction of new towns in its catchment area. Even now, in a dry summer, it is possible only partially to use the reservoirs and filtration plant in the Lee Valley during the periods of low flow, and before long the Board will be faced with the alternative either of providing additional plant in the Thames Valley to convey further quantities of filtered water to East London and thus at times render redundant plant in the east or of conveying raw water from the Thames to the Lee Valley reservoirs to supplement the abstraction from the River Lee. We are of opinion that the second course would be the better, and that a raw water conduit should be constructed in a deep-level tunnel from the Thames to the Lee Valley with an additional intake and pumping station on the Thames. As the Thames would thus be supplementing in raw water what in dry summers it has, and otherwise would have, to supply in filtered water, no additional drain on the Thames' resources would be entailed and the requirements of this service have been taken into consideration in the proposals already described.

* From a Report of the Works and Stores Committee to the Metropolitan Water Board. April 30, 1948.

British Association's Annual Meeting

The 110th annual meeting of the British Association for the Advancement of Science is to be held at Brighton from September 8th to 15th, under the presidency of Sir Henry Tizard, F.R.S. Since its foundation in 1831, the British Association has held only one meeting in Brighton. This was in 1872, under the presidency of Dr. W. B. Carpenter, F.R.S.

The opening general session of this year's meeting will take place in the Dome, Brighton, on Wednesday evening, September 8th, at 8.30 p.m., when the Mayor of Brighton will welcome the Association and Sir Henry Tizard will deliver his Presidential Address on "The Passing World." On the following days, the sectional meetings will be held, those of Section G, Engineering, taking place in the Royal Pavilion. Wing-Commander T. R. Cave-Browne-Cave is this year's President of Section G, and his address, which will be delivered on Thursday, September 9th, will deal with the subject of "Young Engineers." The papers to be discussed in Section G include contributions on the dehydration of sludge, railway locomotive developments, the application of statistics in engineering, instrumentation and control, applicable mathematics, and building materials.

Other events during the meeting include a reception by the Mayor of Brighton on Friday evening, September 10th; an address on "Science and Philosophy," by Viscount Samuel, on Sunday evening, September 12th, and a discourse on "Waves and Beaches," by Professor J. D. Bernal, F.R.S., on Monday evening, September 13th. Among the sectional excursions are visits to the Royal Observatory at Hurstmonceux, Brighton waterworks, the Southwick power station, Brighton railway works, Portsmouth Dockyard, and to various local factories.

The Mobile Locomotive Testing Plant of the London, Midland and Scottish Railway*

By H. I. ANDREWS, Ph.D., M.Sc. (Eng.), A.M.I.Mech.E.†

(*Continued from page 435, April 30th*)

The bogies of the higher-speed units Nos. 2 and 3 are similar to those of the low-speed unit, except that the generators are fully supported from the bogie frame. These generators have extended arms, which are bolted to brackets at the headstocks, the headstocks being considerably strengthened to carry the additional weight. To ensure that no force can be transmitted by the generator castings, the noses are supported in resilient mountings like those of the low-speed bogies. The gear wheels are mounted on short hollow quills which are carried in bearings, attached to the generator frames, corresponding to the suspension bearings of the low-speed generators. The axles pass freely through these quills, sufficient radial clearance being left to allow for the vertical movement of the axle-boxes. The two sets of bogies are identical, except for the gear ratios, which are 35–86 for the high-speed and 27–86 for the medium-speed bogies. The gear ratio of the medium-speed bogies can be altered to that of the high-speed bogies by merely changing the pinions and gear-cases, the necessary alteration in the bearing centres being obtained by rotating the split sleeves of the quill bearings in their housings, these sleeves being eccentric by an amount equal to half the difference between the gear centres. At the same time, the generators must be moved the requisite distance in the bogie frames, alternative bolt holes being provided for each position. Thus the generators can be fitted only in one position on the high-speed bogies, but on the medium-speed bogies they can be fitted in either of two positions, and the frames are arranged so that the pinions may be changed without removing the generators.

The flexible axle drives are of a type which has been developed by the author in connection with the English Electric Company for use in high-speed motor coaches, with the object of improving riding and of reducing the excessive wear such vehicles usually produce upon the track owing to their unsprung weight. They are designed to permit a vertical movement of the axleboxes in the axlebox guides of $\pm\frac{1}{2}$in, and can also accommodate lateral displacement of the axle or out-of-alignment. The drive, which is contained within the specially constructed gear wheel, consists essentially of four links and a floating member, and connects the gear wheel with a disc crank mounted on the axle, as shown in Fig. 7. This arrangement of drive does not introduce any angular discrepancy between the relative positions of the driving and the driven members, a feature of particular importance as the drive is required to operate at speeds up to 900 r.p.m. and it has been found by experience that at high speeds any such irregularity in the motion of a drive inevitably leads to excessive wear or failure of the parts. All the links are fitted with needle roller bearings, the two bearings at the crank pins having outer races in the form of spherical bushings, while the two corresponding bearings on the floating member are of a special form, giving only two degrees of freedom, as shown in Fig. 8. The floating member, which is of forged steel and of U section, is supported laterally from the gear wheel by roller bearings of a simple form having a single roller, the outer races of which are inserted through the side members of the gear wheel. The gear rim, in which the teeth are cut, is forged of nickel-chromium-molybdenum steel, the side members being steel castings.

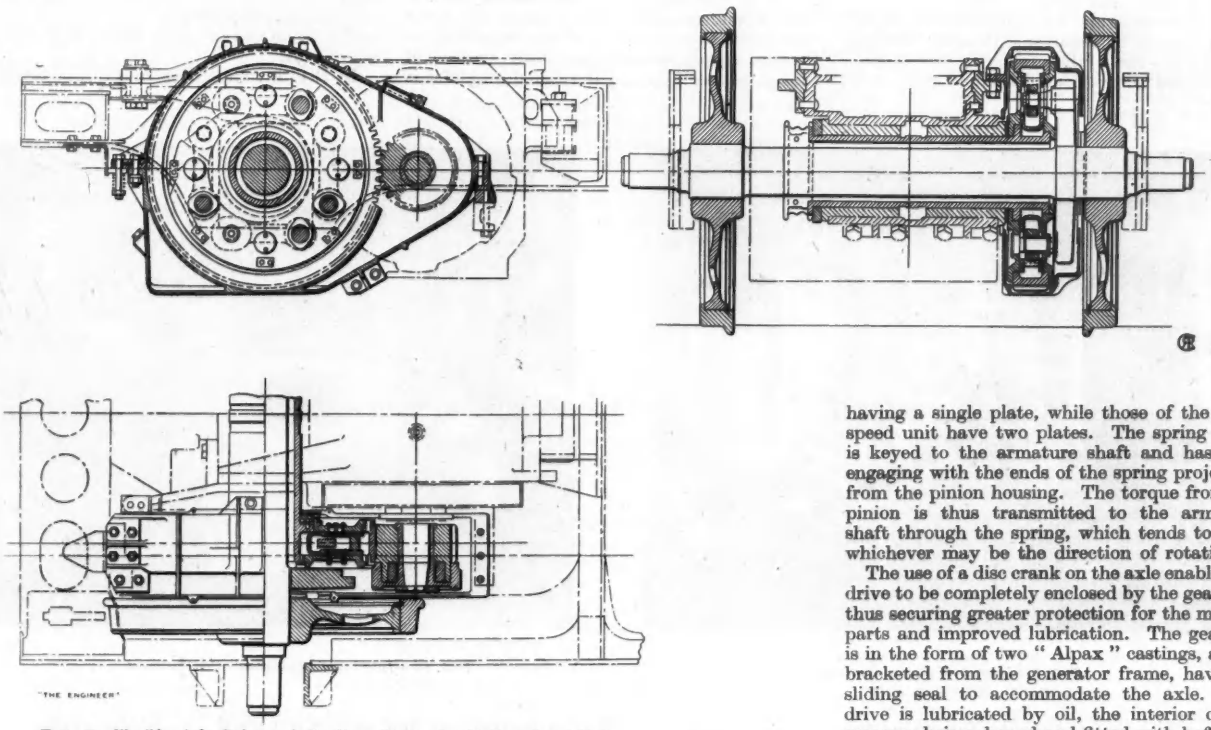


FIG. 7—*Flexible Axle Drive and Resilient Pinion for Medium-Speed Unit*

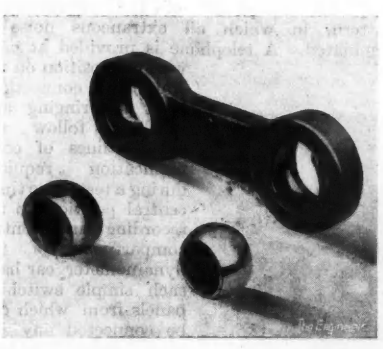


FIG. 8—*Flexible Axle Drive Link with Self-Aligning Bearings*

The resilient pinion, shown in Fig. 11, which is mounted on the armature shaft of the generator, comprises three members, the pinion, spring and spring cover. The pinion is free, of itself, to revolve around the armature shaft on a bronze sleeve bearing, and carries a shaped extension to accommodate the spring. The spring is made of steel plate bent back upon itself, the springs for the medium-speed unit having a single plate, while those of the high-speed unit have two plates. The spring cover is keyed to the armature shaft and has jaws engaging with the ends of the spring projecting from the pinion housing. The torque from the pinion is thus transmitted to the armature shaft through the spring, which tends to close whichever may be the direction of rotation.

The use of a disc crank on the axle enables the drive to be completely enclosed by the gearcase, thus securing greater protection for the moving parts and improved lubrication. The gearcase is in the form of two "Alpax" castings, and is bracketed from the generator frame, having a sliding seal to accommodate the axle. The drive is lubricated by oil, the interior of the gearcase being shaped and fitted with baffles so that the gear wheel itself becomes a pump automatically supplying oil to the gear teeth.

The controls of the unit are all centralised in the electrician's compartment, the interior of which is shown in Fig. 10. On one side of this compartment is a panel carrying the main thyratron controls for the unit, together with a thyratron voltage regulator for the a.c. supply, and a set of master controls which can be used, with a tachometer generator driven from one of the axles, for independent operation of the vehicle. On the opposite side is a panel carrying the controls and instruments for the main generators, for the auxiliary supply and for the exciting generators. The loading of the main generators is controlled by their excitation, and switches are provided for individually shorting out their fields if necessary. As the auxiliary power supply may be obtained from either the auxiliary generator or the battery, the usual arrangements are made for paralleling these to each other and to the train bus-bars, the loading of the generator being regulated by a hand rheostat in its field circuit. A multiple contactor, actuated by a reverse current relay in the armature circuit of the auxiliary generator, provides for operation of the clutch and change-over of the machine from generating to motoring should failure of the engine occur. Thus, if for any reason the torque of the engine fails and the armature current in the auxiliary machine becomes reversed, the thrustor is actuated from the a.c. supply, declutching the engine; the field resistance of the auxiliary machine is altered and an additional differential field is introduced, so that the speed of the three machines remains constant. The various auxiliaries and the auxiliary machine can then be supplied from the battery for about an hour irrespective of the working of the engine, which may be stopped if required. This action can also be initiated by push button or by a thermostat indicating overheating of the engine. If the engine is running at its normal speed the procedure may be reversed by depressing

* Institution of Mechanical Engineers, Friday, April 16, 1948. Abridged.

† Engineering research staff, London, Midland and Scottish Railway.

another push button on the panel, when the auxiliary machine resumes generating. A motor starter, with starting resistance, can be brought into use should the three machines be required to start without the use of the engine. At the rear of the compartment is a further panel carrying the switchgear for the fans and blowers, and also a number of warning lights actuated by thermostats in each generator and above each main resistor. Immediate warning of any serious overheating is thus reproduced in each electrician's compartment, and at the control panel of the dynamometer car.

The three units and the dynamometer car are interconnected by removable jumpers carrying the train bus-bars of the auxiliary power supply. For internal connections a shallow cable duct is provided beneath the corridor throughout the length of each vehicle, including the tender and the dynamometer car.

The Automatic Control.—The function of the automatic control is so to regulate the loading of the main generators that the speed of the train, as indicated by the voltage of the tachometer generator, is maintained at some preset value irrespective of changes in the drawbar pull of the locomotive or the resistance of the train. It can, of course, also regulate in accordance with any other factor directly affected by the generator loading, providing such factor can be represented as a voltage; for example, it may be arranged to maintain constant drawbar pull. Also, by adjustment of the present value, any desired function of speed, tractive effort, &c., may be reproduced.

The control consists essentially of the master control and a valve amplifier on the dynamometer car, and controlled thyratron rectifiers feeding the exciting generator field on each of the braking units. While these controlled rectifiers are identical in construction, they may be adapted by switching so that one rectifier acts as "leader," while those of whichever other units may be connected work as "followers." The general principles upon which this apparatus has been designed have already been described by Whiteley (1936 and 1946).

The master controls on the dynamometer car are built in the form of a desk, while the signal amplifier is accommodated in the lower portion of the main panel. On the automatic control panels on the braking units the master controls for independent operation of the unit are on the right-hand section; the voltage regulator for the a.c. supply occupies the lower portion of the central section, and the signal amplifier is on the left-hand section. To prevent loss of control due to failure of any tube, each valve or thyratron is duplicated in parallel, so that, while the load is normally shared between the two tubes, either is capable of sustaining the full load should its partner fail. In the case of the valves, failure is indicated by a milliammeter in each anode circuit, but on failure of any thyratron the resulting lack of balance operates a relay, lighting a red lamp in the electrician's compartment in each unit. The voltage regulator is a grid-controlled thyratron rectifier supplying d.c. to the field of the alternator, so that its output voltage, when rectified, balances against a fixed reference potential obtained from voltage stabilisers.

Incorporated with the master controls is telephone equipment of the laryngaphone pattern, in which all extraneous noise is eliminated. A telephone is provided at each working position on the train, and connections both for ringing and speaking follow the natural lines of communication required during a test. The three central positions in the recording and control compartment of the dynamometer car have each simple switching panels from which can be connected any desired "family" of outstations, the telephones actually in circuit at any time being indicated by small lamps.

Conclusion.—It was realised from the outset that an apparatus of this type could be employed for a wide variety of work, and care was taken in design that the equipment should be as flexible as possible for adaptation to any tests that might be required. Provision has been made in the equipment for testing diesel locomotives, and space has been left on the dynamometer car and each unit for temporary installation of meters for testing electric locomotives or trains.

During the summer of 1939, measurements were made of the coal consumption of locomotives on the Derby-Burton-Leicester circuit, and a further series of similar tests was projected for the following winter on the line between Skipton and Carlisle. These routes have too severe gradients to be really suitable for testing, but were chosen so that experience might be gained of the working of the control equipment.

In 1947 a comprehensive series of resistance tests was carried out on the lines between Rugby and Peterborough. For these tests the train is marshalled as follows:—Locomotive, mobile testing unit, dynamometer car in reverse and vehicles to be tested. The speed of the train is maintained constant by the resistance of the braking unit, and the resistance of the vehicles on suitable sections of track is measured directly by the dynamometer. These results must, of course, be corrected for gradient and wind, but no allowance need be made for acceleration. Simultaneous readings are taken of wind speed and direction, the additional resistances due to which may be analysed so that the resistance of the train in any wind can be calculated. It is clear that this form of test will also determine the performance of railcars or motor coaches, as measurement may be made at constant speed of both their running resistance and their net tractive effort, from which the gross tractive effort can be calculated.

The equipment may also be employed in connection with a large number of railway investigations other than the measurement of performance. For example, tests have already been made in which the speed of the train or the braking effort have been controlled in accordance with some prearranged function. Thus the resistance of a train measured on some particular section of track may be reproduced elsewhere, or the performance of a particular locomotive can be simulated on a line over which it is not permitted to run. Valuable observations have also been made under controlled conditions in relation to such problems as the creep of tyres and the coefficient of friction during wheel slip.

It is hoped that the availability of accurate information as to the performance and efficiency of locomotives, and the resistances of vehicles and track, will greatly stimulate the employment of many forms of speed-time calculation which have proved valuable in connection with electric traction, but whose use in connection with steam locomotives has hitherto been limited by lack of accurate data.

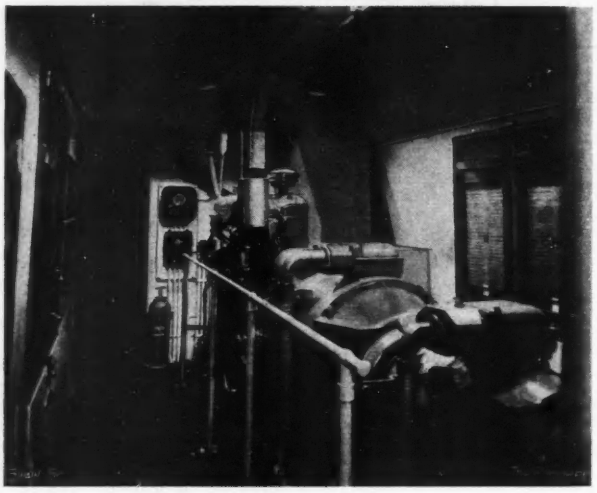


FIG. 9—*Interior of Engine Compartment*

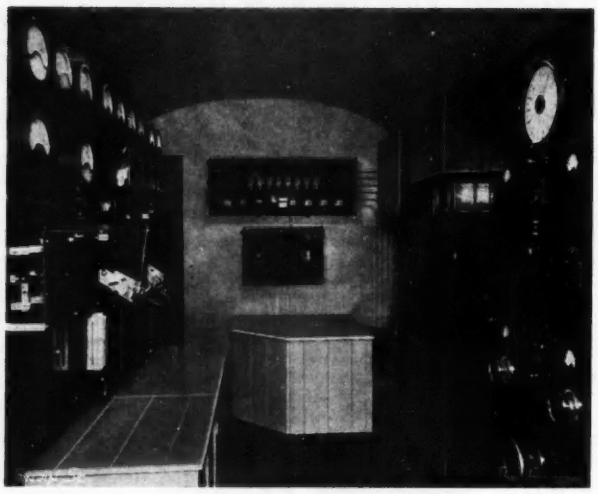


FIG. 10—*Interior of Electrician's Compartment*

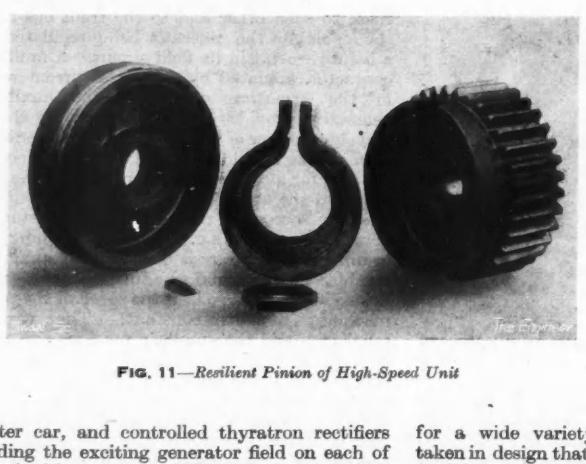


FIG. 11—*Resilient Pinion of High-Speed Unit*

Canadian Engineering Notes

Pulp and Paper

To meet an unprecedented demand, Canadian mills in 1947 produced more newsprint than ever before—a tonnage 47 per cent higher than the average of the five pre-war years. Preliminary figures put the entire pulp and paper industry's production last year at 700 million dollars. Newsprint production for the year totalled 4,490,000 tons, an increase of 354,022 tons, or 8·6 per cent over the 1946 total of 4,135,978 tons. In relation to the Canadian export trade as a whole, the export figures for the industry are very high. The industry as a whole has had no small measure of success in the difficult task of meeting the present demand for its products. Amongst other difficulties the demand for pulp and paper has necessitated developing new forest areas at a time when costs are at their peak. New roads, dams and other very extensive capital expenditures have had to be made in order to meet the needs of forest management. Strides have also been made in other spheres. In the mills satisfactory technical progress has been achieved during the past year. These advances range from mechanical improvements, including faster paper machine speeds, to improved processing resulting from studies in the intricate field of cellulose chemistry. The mills, too, are steadily increasing the utilisation of the by-products of the pulping process. During 1947 production of all grades of pulps increased. The overall increase in output amounted to more than 10 per cent. Mechanical pulp production was up some 8½ per cent, but production of all chemical pulp increased by 15 per cent. The output of market pulps as distinct from those produced for use at the mills has also been increased. These pulps are sold chiefly in export markets. Exports of chemical pulp increased in 1947 by almost 20 per cent. Exports of mechanical pulp increased by just over 20 per cent.

Liquefied Sulphur Dioxide

At the recent annual meeting of the Canadian Pulp and Paper Association it was stated that a way had been found to produce on a commercially feasible basis liquefied sulphur dioxide from smelter gases produced at the International Nickel Company's refinery at Copper Cliff, Ontario. First application of the discovery is to the sulphite pulp industry, major consumer of elemental sulphur which the new product is designed to replace. The announcement was made by Mr. E. H. Lougheed, assistant manager of the Abitibi Power and Paper Company, who said that his company had operated one of its mills for about three months on this material. The process has been developed by collaboration between research workers of the International Nickel Company and Canadian Industries, Ltd.

Rolling Stock Manufacture

The year 1947 was one of considerable difficulty for manufacturers of railroad rolling stock in Canada. Strikes in the steel plants and work stoppages in other feeder industries combined to hamper production of railroad cars, and it was not until late in the year that Canada's three manufacturers were able to make deliveries of anything like normal volume. While production was disappointing in 1947, the amount of business contracted for was encouraging. The Canadian railroads launched elaborate programmes for bringing their rolling stock up to normal once more, following the war years in which their equipment was subjected to a very heavy burden. During the past year orders for rolling stock placed by Canadian railways with the Canadian industry totalled 56,155,800 dollars. It is likely this year that the European Continent will absorb a substantial portion of Canadian exports in this field. It is to be anticipated that Canadian production will be closely integrated with that of the United States in the master plan for continental rehabilitation approved at the Paris Conference last autumn. For Canadian producers, that plan may be expected to spread into two distinct prospects for expanded business. There is, first, what is known as the Marshall plan proper. Canadians already have received the very welcome news that the United States will look to Canada for billions of dollars' worth of supplies which will be shipped to countries in Europe and will be paid for in U.S. dollars. Secondly, the Canadian Government has already made it clear that the Dominion intends participating directly in the rehabilitation effort. All this promises more business for Canadian manufacturers of railroad rolling stock.

Nickel

World deliveries of Canadian nickel in all forms for the year 1947 were greater than those of 1946, although considerably under the wartime record reached in the year 1943. Deliveries in all markets approximated to those of the industry's greatest peacetime year of 1937, and shipments in the United States and Canada showed an increase of about 50 per cent over 1937. Operations of International Nickel at Copper Cliff, its mining and smelting centre, were substantially higher than in 1946, despite a continuing labour shortage. The largest consumer of nickel during 1947 continued to be the steel industry. Production of nickel-chromium stainless steels in the United States accounted for a major portion of this consumption. The applications of nickel-containing stainless steels in the various industries continue to be numerous and diversified. The chemical, petroleum and transportation industries remain important users of stainless steels. The so-called triple alloy steels, containing nickel, chromium and molybdenum, continued to be extensively employed in 1947, particularly in the automotive, construction, railway, tractor and machine tool industries. Their tonnages were again the largest of any single class of engineering alloy steels. The rapid advances in jet engines accounted for an increase in the use of Inconel because of the ability of this high nickel-chromium alloy to withstand the high temperatures and corrosive gases. The same alloy has also assumed further importance for heat-treating equipment. A potentially large market for high nickel heat resistant alloy steels for jet engines and rocket developments is indicated by the continuing search for materials to withstand higher temperatures.

Big Hydro-Electric Project

From the Mississauga tunnel, a scenic wonder of Ontario's northland, the Hydro-Electric Power Commission of Ontario plans to generate 58,000 horsepower of electricity to meet the growing industrial and domestic demand. A construction gang of some 350 men now is engaged in preliminary work, which will lead to construction by the end of another year of one of Ontario's highest dams, a 230ft structure rising to the top of the rocky gorge through which the Mississauga River flows towards its outlet at Lake Huron. The main dam of the project, first to be undertaken by the Hydro Commission in the Algoma district, will be 900ft long and 190ft wide at the base. Plans call for a 950ft side dam on its west flank and on the east a 188ft sluiceway to carry off surplus water. It is estimated that the dam will raise the water level of the Mississauga 190ft. It will create a lake some 12 miles long and up to 3 miles in width, flooding 5000 acres. A start on the main dam is expected to be made by July or August of this year and it is planned for completion early in 1949. The dam will require 180,000 yards of concrete and a total of 220,000 yards will be needed for the entire scheme, including the power-house.

Construction

Construction contracts awarded in Canada totalled 718,137,100 dollars for 1947. Topping the 700 million dollar mark for the first time, Canada's construction industry enjoyed the busiest year in its history. Still beset by material shortages and lack of skilled labour, most contractors managed to complete a greater proportion of work by the year's end than for several building seasons past. The volume for 1947 was 54,782,000 dollars over the 1946 total, but the 8 per cent gain in dollar volume was offset by increased costs. But the rate of capital investment in new construction is now almost four times as great as in 1939 and 25 per cent higher than the 576 million dollar total for 1929, peak year of the post-World War I building boom. Engineering construction for the year reached 167,915,000 dollars, up 35 per cent from the 125,170,600 dollar total for 1946. Biggest gain in this category was 41,663,700 dollars for dams and wharves, reflecting the great hydro-electric construction programme under way. Several provincial highway departments report that more extensive road building programmes were restricted by shortages of equipment and materials. Particularly in short supply was steel for bridge building.

Earthquakes and the St. Lawrence Project

Effects of possible earthquakes in the Cornwall area on the proposed St. Lawrence seaway and power project were discussed at the annual meeting of the Geological Society of America, convened in Ottawa recently. Charles P. Berkey, of Columbia University, who studied the effects of the Massena-Cornwall earthquake on September 4 and 5, 1944, presented a paper describing the engineering implications of the disturbance. It was his opinion that the possibility of future disturbances will increase the engineering difficulties of building the principal works of the waterway development as proposed by United States engineers. It appears certain that those structures which could be established on sound rock foundation, such as dams, locks and power-houses, would be in no danger from an earthquake similar to that of 1944. But structures involving loose sands and silts, particularly the marine silt deposits, would require special handling. This latter condition characterises a considerable portion of the main canal.

New Research Division

A radio and electrical engineering division has just been established by the National Research Council. The new division is to consolidate work formerly carried on in the division of physics and electrical engineering. Advances in radio techniques and related fields, which were so outstanding during the war, broadened the scope of this work until it became first a branch and now a full division. Head of the new division is Mr. B. G. Ballard, O.B.E., B.Sc., who has been in charge of the electrical engineering laboratory since his appointment to the staff in 1930. He is a member of the administrative board of the Canadian Standards Association, Approvals Division, a body which is responsible for ensuring safety in the design of electrical equipment and apparatus marketed in Canada.

Proposed Pipeline

Imperial Oil, Ltd., is considering construction of a 30,000,000 dollar pipeline to carry crude oil a distance of 500 miles from Edmonton, in the Province of Alberta, to Prairie refining centres at Regina and Moose Jaw, in the Province of Saskatchewan. The company also announces a 20,000,000 dollar exploratory well-drilling programme for the Leduc-Calmar sector of the Edmonton oilfield this year, and erection of a gas-gathering system and a 1,500,000 dollar gas-absorption plant for the same field.

Coke-Oven Plant

Announcement has been made by Dominion Foundries and Steel, Ltd., that a blast-furnace and coke-oven plant will be installed at its Hamilton works at a cost of 15 million dollars, which is expected to aid in relieving Canada's annual steel shortage of 500,000 tons. About half the annual production of 300,000 tons of pig iron will be sold in Canada. The production is expected to diminish import of scrap iron from many sources throughout the world. The blast-furnace is expected to turn out 800 tons daily.

Industrial and Labour Notes

The Association of British Chambers of Commerce

The eighty-eighth annual meeting of the Association of British Chambers of Commerce was held in London on Thursday and Friday of last week, and, as was to be expected, Sir Arnold Gridley devoted the greater part of his presidential address to a survey of current industrial affairs. One of the outstanding features of the past year, he said, had been the closer co-operation of the Federation of British Industries, the National Union of Manufacturers, and the Association on major problems affecting Government policy. It seemed clear, Sir Arnold commented, that the present Government felt it more and more advantageous to confer with nationally recognised industrial and commercial associations.

Later in his address, Sir Arnold emphasised that the wholehearted co-operation of Government, industrial leaders and employees was essential if our former position as a great power and a leading industrial nation was to be regained. The Association, he said, took every opportunity of working with the Government and of submitting to the Government its views as to the steps which should be taken to hasten recovery. At the same time, the Association retained inflexibly its view that the nationalisation or socialisation of industry could do nothing to restore industrial prosperity. The Association, Sir Arnold went on, therefore reaffirmed its view that the State acquisition of basic industries had gone far enough—indeed, too far—and that the reiterated intention to nationalise the steel industry would be, if carried out, a crippling and indeed a criminal blunder. An industry which competed for overseas contracts might, if nationally owned or controlled, lead us into international complications which could threaten the restoration and maintenance of world peace.

The Steel Industry's Progress

In the latest issue of its Monthly Statistical Bulletin, the British Iron and Steel Federation has commented upon the record output which has been achieved by the steel industry in the first three months of this year. For the quarter as a whole steel production was at an annual rate of 14,933,000 tons, which was an increase of 9 per cent on the annual rate achieved in the fourth quarter of 1947.

The Bulletin says that the steel industry may thus claim to be making excellent progress towards its 1948 objective of 14,000,000 tons, but it is important that the first quarter's results should not be misinterpreted. It has to be remembered that steel workers in general get two weeks' holiday in the year, so that production in certain months must be above the target level if the required output for the year as a whole is to be achieved. Furthermore, it is pointed out that other factors, such as weather conditions and the need for periodical plant overhauls, may exercise a seasonal influence on steel production.

Taking the normal seasonal pattern into account, the Federation suggests that steel production in the first, second and fourth quarters of the year would require to run at a rate of about 2 per cent above the average rate for the year, while in the third quarter production would be about 6 per cent below the yearly average. On this showing, production in the first quarter was well above the annual rate required for the attainment of this year's target. The Federation's observations on how the first quarter's result was achieved and on the prospects of maintaining the current high level of steel production are contained in an article on another page of this issue of THE ENGINEER.

The T.U.C. and the Economic Situation

At its monthly meeting on Wednesday of last week, the General Council of the Trades Union Congress considered a report of its special committee on the economic situation, and discussions which had taken place with the Chancellor of the Exchequer since the introduction of the Budget.

An official statement issued later said that the General Council realised that because of the uncertainty of the future movement of external prices, the probable course of domestic prices and the cost of living could not yet be clearly estimated. At the same time, it was recognised that there were encouraging indications that the Chancellor's policy in dealing with limitation of profits and control of prices would accomplish its objects. The special committee was authorised to continue examination of the situation in order that the General Council might be enabled to carry out its undertaking to make a quarterly review of prices and profits with a view to giving guidance to affiliated unions.

Another matter reported to the General Council last week related to the reciprocal recognition of trade union cards. Fifty trade unions, representing 3,200,000 workers, it was stated, had agreed to the mutual recognition, without qualifications, of the cards of those of their members who came under the Control of Engagement Order, on the understanding that the T.U.C. would review the whole question before the end of the year. Another ten unions, it was added, were prepared to operate schemes of recognition with specific unions, that is, with any individual union from the membership of which a transfer of employment took place.

The National Joint Advisory Council

The quarterly meeting of the National Joint Advisory Council, representing the British Employers' Confederation and the Trades Union Congress, took place in London under the chairmanship of the Minister of Labour, on Wednesday of last week. Amongst the matters which the Council considered were the desirability, in the present time of labour shortage, of persuading employers to retain elderly workers in their employment, and persuading elderly people themselves to stay on at work; the Employment and Training Bill, which is now before Parliament; and the Economic Survey for 1948, and the progress so far made towards the attainment of the targets which it sets out.

The Minister of Labour also directed the Council's attention to the general question of restrictive labour practices, and to the statement made by the Lord President of the Council in the recent debate on the Monopoly (Inquiry and Control) Bill. The Lord President said on that occasion that the National Joint Advisory Council afforded the best forum for a preliminary discussion of the manner in which restrictive labour practices, which were alleged to impede production and industrial expansion, should be investigated. A statement issued after last week's meeting said that a general exchange of views took place, in the course of which reference was made to the Restoration of Pre-War Practices Act, 1942. In view of the necessity for consultation with constituent organisations, however, it was decided that the Council should resume discussion on the matter at a later date.

Price Reductions

Among the manufacturing firms which have recently announced price reductions are Stewarts and Lloyds, Ltd., which is giving a special discount to home trade customers of 2½ per cent off the prices of approximately 90 per cent of the steel tubes which it produces. It is explained that increased output and the benefits of plant improvements have resulted in economies which have enabled this price reduction to be made. A similar announcement has been made by the Wellington Tube Works, Ltd., which is making a price reduction of 2½ per cent on all tubes and fittings delivered in the home trade from May 1st. Both companies point out, of course, that should there be any increase in raw material or labour costs, the matter would have to be reconsidered.

Imperial Chemical Industries, Ltd., has also stated during the last week that it has decided to reduce prices over a wide range of its products. The effect of the decision, the company says, will be to save its customers more than £1,000,000 during the next twelve months. In some instances, the reduction will apply in the shape of specific price decreases, and in others it will take the form of a special percentage reduction covering certain ranges of goods.

The Confederation of Shipbuilding and Engineering Unions

The annual conference of the Confederation of Shipbuilding and Engineering Unions was held at Weston-super-Mare on Monday, Tuesday and Wednesday of this week, and was attended by delegates of the thirty-four affiliated societies. The retiring President, Sir Mark Hodgson, addressed the conference on Monday morning and in the course of his remarks expressed his conviction that the workers were prepared, as hitherto, to make any necessary sacrifice so long as they were assured that they were not making the sacrifice alone. He thought, however, that it would be impossible to peg wages if the costs of the essential commodities were going to be allowed to rise.

Later in his address, Sir Mark referred to the shipbuilding industry, saying that there was an abundance of orders but not sufficient steel. Pockets of unemployment would, he thought, develop, and unless steel supplies were considerably increased, the position would get worse and there would be considerable unemployment. Similar complaints about the shortage of steel were coming, Sir Mark commented, from workers in the motor vehicle and agricultural machinery industries. The Confederation, he declared, would continue to press for such an essential commodity as steel to be made available to those industries on which the nation so much depended.

Among the many resolutions submitted to the conference was one from the Amalgamated Engineering Union, placing on record that in the worsening national situation, improved productivity and increased production were becoming more vital than ever. The resolution went on to warn "those employers who had failed to face up to the changed situation," that their insistence on the maintenance of managerial functions and their neglect to introduce improved administration and production methods constituted a serious obstacle to increased production. Finally, the resolution called upon the Government to take a more realistic view of the situation and adopt a firmer policy towards opposition to the introduction of improved methods of production, of management and administration, and towards the control of prices and profits.

The Shorter Working Week

Speaking at the annual meeting of Hadfields, Ltd., which was held recently in Sheffield, Mr. J. B. Thomas, deputy chairman and managing director, said that the reduction of the weekly standard hours from 47 to 44 had resulted in an increase in production costs. The statement that the same amount of work that was done in 47 hours would be done in 44 had not proved to be true in practice. Production had increased, but, Mr. Thomas stated, this could only be attributed to overtime and incentive bonus schemes, which, while giving extra output, added considerably to the costs. No one, he suggested, begrudged workers better conditions and more leisure, but in view of the serious national position, he thought that the change in working hours had been ill-timed.

French Engineering News

(From our French Correspondent)

The French mechanical industries are now beginning to recapture their place in foreign markets. The Fives-Lille company, which specialises in machinery for sugar plant, has just supplied over 1000 tons of material for use in the sugar cane industry in Brazil. The drop in orders for machine tools which followed the latest price increases is now giving place to a general improvement, and business is being facilitated by the decrease in delivery delays and increased flexibility in trading conditions. The more important plants expect production to increase in 1948 despite continued difficulty in obtaining certain supplies such as ball bearings. At the works of Précision Mecanique turnover since the beginning of 1948 has reached 60,000,000 francs monthly and the re-equipment plan started in 1945 will be completed this year. It includes the installation of workshop plant for the Omnium Metallurgique et Industriel. In 1947 that company doubled its turnover compared with the previous year and was able to respond in a higher degree to ever-increasing orders. Improvement of means of production by the acquisition of new machine tools, particularly suitable for the delicate work undertaken by the company, has also produced happy results with regard to costs.

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According to Monsieur Robert Lacoste, Minister of Industry and Commerce, French miners have now exceeded their production goal of 1000 kilograms per manshift, monthly output now being 4,489,000 tons, compared with the pre-war monthly average of 3,913,000 tons. He also stated that electricity production was 93,000,000kWh daily, compared with 56,000,000kWh in 1938, and gas output was 23 per cent higher than pre-war. Automobile production, he said, was being deliberately restricted to less than one-third of pre-war output. Seventy-three per cent of cars produced were reserved for export. Industrial vehicle production was 117 per cent of pre-war. France's main shortages to-day, stated the Minister, were in non-ferrous metals, particularly copper, and in cotton and wool.

* * *

The new equipment plan for the nationalised coal mines of the Nord and Pas de Calais aims to permit production of 125,000 tons of coal daily as from 1953. Monsieur Andre Terra, writing in the review, *Mines*, states that the importance of underground galleries will be defined according to their distance from each of the main pits, which should, in principle, each cover an area of fifteen square kilometres. Each central pit will comprise a complete sorting and washing installation and baths and showers for 2500 men. Daily extraction envisaged per pit amounts to 4000 tons net. In sinking shafts, cementing and timbering in pre-vibrated 60cm thick reinforced concrete is favoured, completed by cementation between timbering and soil. The 3000-litre mine car will be adopted in all new pits. Skips will only be used in exceptional cases because they are too costly. The diameter of new shafts will be between 6m and 6·65m. Monsieur Terra believes that by modernisation 125,000 tons will be obtained daily with fifty-eight pits instead of 112, with an economy of fifty men for each 1000 tons extracted.

* * *

Coal production in France and the Saar for the week March 28th to April 3rd was 1,036,029 tons, of which 857,544 tons was mined in France and 178,485 tons in the Saar, as against 1,235,429 tons for the preceding week, of which 1,043,405 tons was mined in France and 192,024 tons in the Saar. Average output per manshift was 972kg, as against 995kg the previous week.

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According to the Monnet Plan for 1947–50, total expenditure for new work in the supply of refrigeration equipment to agriculture should be 2,677,000,000 francs (1939 value). This figure does not include 200,000,000 francs for buildings and public works.

Notes and Memoranda

Rail and Road

RAILWAY LIGHTING SCHEME AT COVENTRY.—Electric lighting is being installed in the sidings at the Coundon Road, Coventry, goods depot of the London Midland Region of British Railways for loading to be carried on at night.

THE EAST AFRICAN TRANSPORT SYSTEM.—By a proclamation and an order published on May 1st, in the East Africa High Commission Gazette, the two transport systems of East Africa —the Kenya and Uganda Railways and Harbours and the Tanganyika Railways and Ports Services— have been amalgamated into one system to be known as the East African Railways and Harbours Administration. The Colonial Office states that Mr. Dalton, acting general manager of the Kenya and Uganda Railways and Harbours, has been appointed acting general manager of the East African Railways and Harbours, and Mr. Farquharson who, until recently, was general manager of the Tanganyika Railways and Ports Services, has been appointed acting deputy general manager.

EUROPEAN TRANSPORT.—The Economic Commission for Europe of the United Nations says that nearly all the countries of Europe, including the Western Zones of Germany, are now applying the pre-war rules for the exchange of railway wagons in international traffic. Countries within the ECE have agreed in replenishing their stocks of wagons to purchase wagons of a single type in the United States and another single type in Canada. This, it is suggested, will result in the speeding of delivery, and in a greater uniformity of freight vehicles on European railways. As to road transport, a large number of European countries and the Occupying Authorities of Western Germany have agreed to the removal of most restrictions on international lorry transit through their territories. Some of them have also freed international transport of goods by roads.

Air and Water

RADIO AIDS FOR JERSEY AIRPORT.—The States of Jersey are equipping their airport, which is one of the busiest in Europe, in proportion to its size, with new radio aids. One of the systems to be installed is known as ABAS (aircraft blind approach system). Based on the American SCS.51 system, it has been developed and produced by Pye Ltd., of Cambridge, with the technical collaboration of the Marconi Company. The system permits an aircraft to be flown along a prescribed track down to within a few feet of the runway. The airport is also to have new Marconi very high frequency direction finding equipment, which will be capable of remote operation from distances of up to 30 miles over normal telephone lines, the equipment itself being unattended. The aerial system is capable of providing direction finding information on as many as four different frequencies simultaneously.

THE INTERNATIONAL SHIPPING FEDERATION.—On the invitation of the Portuguese Shipowners' Association, the International Shipping Federation will hold its next annual conference in Lisbon on May 12th and 13th. The Federation was founded in 1909 and its principal fields of activity are industrial relations in the shipping industry and all personnel questions. The main items on the agenda of the conference are the conventions adopted at the Seattle Conference in June, 1946, and the proposals of the International Labour Organisation for expediting their ratification; the relationship between the International Shipping Federation and the United Nations in general, and the proposed Inter-Governmental Maritime Consultative Organisation in particular; the decisions of the International Radio Conference of 1947, and crew aspects of the International Safety Conference at present meeting in London. The president of the Federation is Mr. Basil Sanderson (Great Britain).

Miscellanea

THE LATE MR. R. S. ANDERSON.—We record, with regret, the death of Mr. Robert S. Anderson, which occurred recently at Motherwell. Mr. Anderson was managing director of Marshall, Fleming and Co., Ltd., with which company he had recently completed fifty years' service.

PROPELLER TEST BEDS AT HATFIELD.—Mr. A. B. Newby, A.M.I.C.E., partner of Mr. H. Iorys Hughes, of 66, Victoria Street, Westminster, S.W.1, was in charge of the civil engineering work in connection with the construction of the propeller test beds at Hatfield, described in our issue of April 2, 1948.

THE MANCHESTER OIL REFINERY.—To mark the completion of ten years of oil refining operations in this country, Manchester Oil Refinery, Ltd., has just produced an illustrated brochure entitled "The First Ten Years." It records the achievements of and the progress made by the company during those years and gives a comprehensive description of the refinery itself.

INCREASE IN OIL PRICES.—The Ministry of Fuel and Power, in consultation with the Petroleum Board, has approved increases in the selling prices of the following petroleum products, sold in this country for inland consumption, as from May 1st: diesel oil for road vehicles, ¾d. a gallon; white spirit, 1d. a gallon; burning oil (paraffin), ¾d. a gallon; vaporising oil, ¾d. a gallon, and bitumen, 9s. a ton. It is stated that these increases are caused by the advances in world oil prices.

PROTECTIVE COATING ON STAINLESS SHEET.—The executive committee of the Stainless Steel Fabricators' Association of Great Britain states that it has discussed the question of the use of a protective coating on stainless steel sheet. Although it understands that certain firms are experimenting with the process it wishes to record its disappointment that no such process is yet available to the trade, which, the Association considers, is placing the trade at a disadvantage when competing with American fabricators.

SHIHCHINGSHAN IRON WORKS.—The Shihchingshan Iron Works, one of China's oldest foundries, some 19 miles from Peiping, resumed operations a few weeks ago. Production for the time being is to be limited to 150 tons of essential pig iron daily, the furnace being fired for only five hours a day. The plant is said to be faced with a shortage of raw materials, which are obtained largely from Communist-occupied areas. It has on hand a supply of iron ore sufficient only for two months, and its lime supply is sufficient only for a month and a half.

DINNER TO THE ELECTRICITY COMMISSION.—The British Electricity Authority gave a dinner on April 26th, at the Dorchester Hotel, London, in honour of the Electricity Commission. The party included the Chairman, Lord Citrine, members and senior officers of the Authority, with the Commissioners and their senior officers. Sir Cyril Hurcomb was also an honoured guest. The occasion was informal, but Lord Citrine paid warm tribute to the work of the Commission and its influence on the destiny of electricity supply. Sir Cyril Hurcomb and Sir John Kennedy expressed their appreciation.

TESTS OF REINFORCED CONCRETE COLUMNS.—An investigation relating mainly to various features of reinforced concrete column design is reported in a bulletin entitled "The Effect of Eccentric Loading, Protective Shells, Slenderness Ratios and other Variables in Reinforced Concrete Columns," which has been published recently by the Engineering Experiment Station, University of Illinois. The major features reported upon are the effect of combined bending and direct compression; the effect of column slenderness on strength and manner of failure; and the effect of protective shells as structural elements. Ten groups or series of tests were made over a period of years to study these and related topics, and altogether over 500 columns were tested.

RELAXATION METHODS.—For the last three years Summer Schools in "Relaxation Methods" have been held at the Imperial College of Science and Technology. Their success has encouraged the provision of a similar course in the coming Long Vacation, and this has now been planned for the four weeks July 6th to 30th, 1948. The course will consist of more or less formal lectures with numerous examples to be solved under supervision. To meet the convenience of those who enrol, it is proposed that lectures be given from Tuesdays to Fridays only, but that facilities for practical work be also provided on Mondays. The inaugural lecture will be delivered on Tuesday, July 6th, when every student should be present. The fee for the course will be £5, payable to the Imperial College. The College will endeavour to provide accommodation in its Hostel building; but it may prove necessary to restrict the number so accommodated. The daily charge for a room and breakfast is 10s. 6d. Other meals are obtainable in the College Refectory. Applications should be addressed to Mr. D. N. de G. Allen, Imperial College of Science and Technology, London, S.W.7. Separate application should be made by each individual, stating the amount of time that can be given to the course, whether bedroom accommodation is desired, and if so whether for the whole period or excluding week-ends.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Supervising Electrical Engineers

To-day, May 7th.—YORK BRANCH: Royal Station Hotel, York. "An Introduction to Mechanical Refrigeration," L. L. Emmett. 7.30 p.m.

Tuesday, May 11th.—S.W. LONDON BRANCH: Compton Hall, Wimbledon. "Installation and Testing," J. P. Mulville. 8.15 p.m.

Wednesday, May 12th.—BRADFORD DISTRICT BRANCH: Midland Hotel, Bradford. "Practical Application of X-Rays from a Diagnostic Point of View," E. Hudson. 7.30 p.m.

Incorporated Plant Engineers

To-day, May 7th.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham. Short talks by four members and discussion about the exhibits at the British Industries Fair. 7.30 p.m.

Tuesday, May 11th.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester. General discussion. 7.15 p.m.

Thursday, May 13th.—NEWCASTLE-ON-TYNE BRANCH: Y.M.C.A., Connaught Rooms, Blackett Street, Newcastle-on-Tyne. "Steam Economy," E. Hurle. 7.30 p.m.—SHEFFIELD BRANCH: Conducted tour of B.T.H. Glass Works at Chesterfield. 7 p.m.

Institute of Marine Engineers

Tuesday, May 11th.—85, The Minories, E.C.3. "Some Aspects of the Manufacture of Large Seamless Steel Tubes and Hollow Forgings," J. W. R. Naden. 5.30 p.m.

Institute of Petroleum

Wednesday, May 12th.—26, Portland Place, W.1. Films Illustrating Various Phases of the Petroleum Industry. 5.30 p.m.

Institution of Civil Engineers

Tuesday, May 11th.—Great George Street, S.W.1. "Coast Erosion and Sea Defence, with Special Reference to Problems on the East Coast of England Associated with the Former London and North-Eastern Railway," T. H. Seaton; "The Effect of Winds and Tides on Sea Coast Defence Works in North Wales," C. R. Irving. 5.30 p.m.

Institution of Electrical Engineers

To-day, May 7th.—MEASUREMENTS SECTION: Savoy Place, Victoria Embankment, W.C.2. Discussion on "The Application of Instruments to Power Station Operation." 5.30 p.m.

Wednesday, May 12th.—SOUTH MIDLAND STUDENTS' SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham. The annual general and thirtieth ordinary meeting. "Thermostatic Controls," R. S. Atkins. 6.45 p.m.

Thursday, May 13th.—Savoy Place, Victoria Embankment, W.C.2. Annual general meeting. 5.30 p.m. Film, "Atomic Physics." 6.45 p.m.

Institution of Engineering Draughtsmen and Designers

To-day, May 7th.—Royal Society of Arts, John Adam Street, Adelphi, W.C.2. "Timber," W. Ivey; and "Aluminium Alloys," R. R. Osborne. 7 p.m.

Institution of Production Engineers

Tuesday, May 11th.—WOLVERHAMPTON GRADUATE SECTION: Wolverhampton and Staffordshire Technical College, Wolverhampton. "Fine Measurement," L. Wilcox. 7.15 p.m.

Wednesday, May 12th.—WOLVERHAMPTON SECTION: Wisemore Schools, Walsall. "Metallurgical Factors Influencing Machinability," L. W. Johnson. 7 p.m.

Junior Institution of Engineers

To-day, May 7th.—39, Victoria Street, S.W.1. "Technical Evidence: Some Reminiscences," W. A. Tookey. 6.30 p.m.

Friday, May 14th.—Royal Society of Arts, John Adam Street, Adelphi, W.C.2. "Coal—Oil—Chemicals," J. G. King. 6.30 p.m.

Royal Institution of Great Britain

To-day, May 7th.—21, Albemarle Street, W.1. "Life in Russia To-day," Edward Crankshaw. 9 p.m.

Friday, May 14th.—21, Albemarle Street, W.1. "The *Rôle* of Chemistry in Combating Tropical Diseases," Sir Ian Heilbron. 9 p.m.

Royal Statistical Society

To-day, May 7th.—LONDON GROUP: E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, W.C.2. "Factorial Regression Analysis," P. Lyle. 6 p.m.

Women's Engineering Society

To-day, May 7th.—35, Grosvenor Place, S.W.1. "Starting an Engineering Business," Miss V. Holmes. 6.30 p.m.

ENGINEERING AND MARINE EXHIBITION.—The next Engineering and Marine Exhibition is to be held at Olympia, London, from August 25 to September 10, 1949. The organisers, F. W. Bridges and Sons, Ltd., Grand Buildings, Trafalgar Square, W.C.2, state that the exhibition will occupy the whole of the Olympia buildings.

Personal and Business

MR. J. RAMSAY GEBBIE has been elected to the River Wear Commission.

MR. G. P. BELSHAM has been appointed a director of Brookhirst Switchgear, Ltd.

CIBA, Ltd., announces that it has acquired a controlling interest in Aero-Research, Ltd., Duxford, Cambs.

MR. W. S. DOUGLAS has been appointed an additional vice-president of the British Refrigeration Association.

THE MINISTER OF FUEL AND POWER has appointed Sir Robert Burrows to be a part-time member of the National Coal Board.

THE BRITISH ELECTRICITY AUTHORITY announces the appointment of Mr. A. Haywood as contracts manager in charge of revenue purchases.

MARSHALL, FLEMING AND CO., Ltd., announces that, in succession to the late Mr. R. S. Anderson, Mr. Stanley Smart, and Mr. J. S. Anderson have been appointed joint managing directors.

BRITISH TIMKEN, Ltd., announces that it has received from the Ministry of Supply approval of the building extension scheme at its Duston factory. It has also received from the Ministry of Works the building licence which will enable work on the extension to begin.

THE MERSEYSIDE AND NORTH WALES DIVISION of the British Electricity Authority announces the following appointments:—Mr. R. L. Batley, A.M.I. Mech. E., chief generation engineer (operation); Mr. D. F. Grant, A.M.I.E.E., and Mr. H. Berry, A.M.I.E.E., senior assistant engineers; Mr. W. J. Norrie, mechanical maintenance engineer; Mr. F. H. S. Brown, A.M.I.E.E., and Mr. A. N. Duffett, A.M.I.E.E., generation engineers (construction); Mr. J. H. Osborn, Mr. J. R. Taylor and Mr. N. A. Steel, resident engineers (construction), at Bromborough, St. Helens and Warrington; Mr. J. A. Spence, M.I.E.E., transmission engineer; Mr. T. B. Airey, senior assistant transmission engineer; and Mr. E. A. Burton, technical engineer.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of report	Title	Post free s.	d.
B.I.O.S.:			
1590	Report of Investigation at Stahlwerke Kabel C. Pouplier, Jnr., at Hagen-Kabel, Manufacture of Hardened, Tempered, Formed, Polished and Blowed, and Cut to Lengths, Steel Strip	1	4
1602	Manufacture and Applications of Vinyl Alkyl Ethers, Acrylates, their Polymers and Co-Polymers	9	9
1605	I.G. Farbenindustrie: The Manufacture of Intermediates and "Colour Formers" for Agfa Farbenfilm	3	8
F.I.A.T.:			
578	Automotive Power Trains, Clutches, Transmissions and Steering Mechanisms	6	2
874	The Manufacture of Ethylene Oxide via Chlorohydrination of Ethylene	5	2
954	A Highly Sensitive D.C. Controlling and Measuring Device...	7	8
1000	The Oxo Process	7	2
1044	A Study of the Optical Works of C.A. Steinheil Soehne, Munich...	5	8
1059 (Supplement No. 1)	The Phase Principle in Microscopy	2	8
1080	The Lower Vinyl Ethers and their Use for Acetaldehyde Manufacture	2	8
1102	Polymerisation of Vinyl Acetate	5	2
1155	Thermal Images for Transformers	3	2
1159	The Printing Ink Industry of Germany	2	2
1176	A New Stereoscopic Effect and its Physiological Interpretation: Report in German	2	2
1186	Acetylene Carbon Blacks	2	2
B.I.O.S.:			
Misc. 42 ...	Insulated Coatings of Electric Motor Coils Developed by Vereingte Lackfabriken, Hamburg	1	1
Misc. 43 ...	Information on Manufacture of Oil Seal Rings (Simmer Rings)...		7
Misc. 44 ...	Experimental Diesel Engine at Motorenwerke, Mannheim ...	1	1
JAP/PR/922	Japanese Fuels and Lubricants: Naval Research on Alcohol Fuel	15	4
JAP/PR/932	The Aluminium Industry of Japan: Part II, Light Metal Fabricating Industry, including Copper and Copper Alloys ...	2	2
JAP/PR/1278	Japanese Hydrography: Organisation, Operation and Methods	6	8
JAP/PR/1290	Oceanography in Japan	5	8
394	Technical Report on the Ruhr Coalfield, Vol. III, Appendix 27, Utilisation of Low-Grade Fuels in Steam Generating Plants ... This report has been published separately by His Majesty's Stationery Office as a Ministry of Fuel and Power publication and should be ordered by title		10
990	The German Perforated Metals Industry	5	2
1052	German Acetylene Chemical Indust y: Acetic Acid	4	8
1147	p-Nitroaniline and Related Compounds: Development of Continuous Amination Processes at I.G. Farbenindustrie, Hoechst...	3	2
1276	Some Aspects of Electrical Contacting Materials and Phenomena Associated with the Design of Electro-Mechanical Devices used in German Telecommunications Equipment	4	8
1391	Development of Loop-Scavenged Two-Cycle High-Speed Compression-Ignition Engines of Small Bore	6	2
1472	Some Aspects of Textile Research in Germany	12	9
1477	Fish Oil Refining with some reference to Marine Animal Oils ...	5	2
1489	Supplementary Report on the German Wood Wool Building Slab Industry	8	2
1506	Investigation of German Hosiery Needle Industry	5	2
1577	The New Potassium Permanganate Plant at I.G. Farben, Bitterfeld	1	1
1581	Wool Grease Extraction and Refining Process of Wollwäscherei und Kammerei of Döhren	1	1
1588	Nitrocellulose and Cellulose Acetate Lacquers and Ancillary Materials (Interrogation of Dr. Alfred Kraus)	2	2
1598	Index of the Major Pest Control Products in the British, U.S. and French Zones of Germany	3	8
1624	Manufacture of Dioxan: The Cyclic Ether of Diethylene Glycol	1	1
1625	Manufacture of Polyethylene Oxide Wax	1	1
F.I.A.T.:			
872	The I.G. Hoechst Glycerogen Process	5	2
887	Lightweight Electric Light Wiring Devices and Conduit Manufactured by the Germans for Export	3	8
1067	A Survey of High-Pressure Equipment Designs in Germany	3	8
1148	The Use of Heat-Resisting Steels in the Manufacture of Gas Turbine Blades in Germany	2	8
B.I.O.S.:			
Misc. 41 ...	German Naval Fuel Oil	2	2
JAP/PR/411	Japanese Naval Aircraft CO_2 System Design	1	1
JAP/PR/826	Japanese Fuels and Lubricants: Research on Rocket Fuels of the Hydrogen Peroxide-Hydrazine Type	11	3
JAP/PR/894	Armour of Japanese Airplanes...	1	1
1428	German Warp Knitting Industry and Hypodermic Tubing Industry, including a report on some Aspects of the German Hosiery Needle-Making Machine Industry	9	3
1530	Investigation of German Methods of Rubber/Metal Bonding ...	8	2
1549	Quarrying and Processing of Block Stone in Germany	2	8
Classified List No. 8, Consolidated list under subject headings of all reports on German and Japanese Industry, published up to and including May 31, 1947		1	3
Classified List No. 9, June, 1947, Supplement to the above list			3
Classified List No. 10, July, 1947, Supplement to the above list			3
Classified List No. 11, August, 1947, Supplement to the above list			3
Technical Index, Alphabetical Subject Index of reports on German Industry, published up to and including July 27, 1946		5	3
Technical Index (Part 2), August, September and October, 1946, Supplement to the above Index		1	7
Technical Index (Part 3), November and December, 1946, Supplement to the above Index		1	7

Technical Information and Documents Unit, German Division, Board of Trade, 40, Cadogan Square, S.W.1, which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

A Seven-Day Journal

International Mechanical Engineering Conference

In our issue of January 16th, we made preliminary reference to the holding of a Congrès International des Fabrications Mécaniques, in Paris, in the autumn of this year, in which British engineering firms were invited by the British Engineers' Association to participate. A printed brochure has now been received from Paris regarding the arrangements made, which at a later date will be followed by a more detailed programme. These particulars can be obtained by applying to the Publications Division of the British Engineers' Association, 32, Victoria Street, London, S.W.1. The date of the Congress has been fixed for Monday, September 13th to Saturday, September 18th. In the first part of the week meetings will be held at which papers will be presented. A large number of papers from all European countries and also America have already been received. They deal with new methods and techniques of metal working and the development of manufacturing processes. It is hoped that the meeting of manufacturers and research workers will perhaps encourage the setting-up of certain international study groups, which will lead to the holding of further international congresses. On Tuesday afternoon, September 14th, visits have been arranged to the works of S.O.M.U.A., Machines Automatiques Bardet, and Pompes Guinard, where machine tool and pump manufacture will be seen. On Thursday morning, September 16th, visits will take place to the works of the Société Rateau, Manufacture Française d'Outillage Facom, and the Compagnie des Compteurs de Montrouge, where the manufacture of turbines, compressors and pumps, also hand tools and measuring instruments will be seen. On the afternoon of Friday, September 17th, it is proposed to visit the Centre de Perfectionnement de L'Aluminium, the Forges et Ateliers de Meudon, and Bernard Moteurs, where light metal working, the manufacture of pneumatic equipment, and oil engines will be seen. The closing dinner will take place on Saturday, September 18th, at Versailles. On the days following excursions have been arranged to the Chateau country and the Arromanches beaches, September 19th and 20th, from Paris and Lille on September 21st, and from September 22nd to 25th to Grenoble and Strasbourg and Bâle, at which the French Machine Tool and Engineering Exhibition, to be held at Bâle from September 18th to 25th, will be visited. Further information with regard to these excursions can be obtained from The Congress Secretary, 11, Avenue Hoche, Paris.

Southern Electricity Board

Mr. H. Nimmo, Chairman of the Southern Electricity Board, addressed a Press conference on May 4th, at the Board's headquarters in Maidenhead, to introduce the new organisation. He explained that the Board had taken over twenty-two local authority and twenty-six company undertakers in the Southern area, which was the second largest in Great Britain; it covered 6500 square miles, from Chiswick to Portland Bill, embracing four counties and parts of eight others, with a population of 3,000,000 people. The number of consumers was approximately 800,000 and the annual revenue was about £14,000,000. At present the Board consisted of Mr. H. Nimmo (chairman), Mr. R. R. B. Brown (deputy chairman), Professor H. G. Saunders, Alderman J. P. D. Lacey, Lt.-Col. E. L. Luce, Mr. W. H. Lawson and Mr. A. Lockwood. Of these only the chairman and deputy chairman were full-time members. The six principal officers were Mr. H. W. Taylor (chief engineer), Mr. F. W. Kempton (secretary), Mr. G. Hicks (chief accountant), Mr. W. B. Poulter (chief commercial officer), Mr. R. Birt (area liaison officer), and Mr. D. S. Cumberledge (legal adviser). For operational purposes the Southern area had been divided into four sub-areas, designated as No. 1, Southall; No. 2, Newbury; No. 3, Portsmouth; No. 4, Bournemouth and Southampton. Each of these sub-areas was controlled by a manager, with the assistance of a principal administrative officer, a senior engineer, a senior accountant and a senior commercial officer. Under the sub-area manager there were local or district executive officers, responsible for the day-to-day operation of their local or district undertakings. These executive officers, who were given a considerable degree of autonomy, would, as in the past, deal directly with the consumers. Mr. Nimmo then went on to speak of the protection given to the user or potential user by the consultative councils, which would be set up under the terms of the 1947 Act, and would serve as the consumer's mouthpiece, maintaining liaison with the Area Board.

Retirement of Mr. Cecil Bentham

At the annual general meeting of Henry Simon, Ltd., held at Cheadle Heath, on Monday, May 3rd, Mr. Cecil Bentham, C.B.E., M.I.C.E., M.I.Mech.E., M.Inst.T., announced his retirement from the chairmanship of the firm, which he has held for fourteen years. On behalf of the Board, Lord Simon of Wythenshawe, the governing director, in making a presentation to Mr. Bentham, spoke with gratitude of his life of service and achievement, of which, he said, he had every right to be proud. Mr. Bentham joined Henry Simon, Ltd., as a draughtsman in 1901, and became head of the conveying department in 1911, a position in which he played an outstanding part in the building up of the firm's mechanical handling business, and in particular in the development of pneumatic handling plants. He was appointed a director in 1916, managing director in 1926, and became chairman of the company in 1934. Always a prominent figure in the engineering world, Mr. Bentham held many important posts. He was president of the British Engineers' Association, and of the Manchester Association of Engineers, and chairman of the North-Western Association of the Institution of Civil Engineers, the North-Western Section of the Institution of Mechanical Engineers, and of the Liverpool and Manchester branch of the Institute of Transport; he is vice-president of the Manchester Engineering Employers' Association, and a member of the councils of the Institution of Mechanical Engineers and of the British Engineers' Association. During the recent war, among other Government appointments, he was Deputy Controller-General of Machine Tools in 1943–44. In recognition of his work, he was awarded the C.B.E. in 1947. Mr. Bentham is succeeded as chairman of Henry Simon, Ltd., by Sir Patrick Hamilton, Bt.

Honorary Observers for the Building Research Station

The D.S.I.R. Building Research Station at Garston, near Watford, Herts, has recently launched a scheme whereby, with the co-operation of the professional institutions forty-seven professional men have been appointed honorary observers for the station. The purpose of the scheme, which was first suggested by the Architectural Science Board of the Royal Institute of British Architects, and was discussed with representatives of the interested professional institutions, is to collect from the building industry information and experience, which is available in the various geographical areas of the country, to collate it and if possible supplement it by the results of research, and then to make it available to industry. The scheme will, it is believed, encourage a closer relationship between building research and the personnel dealing with the day-to-day problems of the industry. It will also provide a channel by which experience throughout the country with newer materials and methods of construction can be readily collected. It should also enable conclusions to be drawn more quickly as to their behaviour and suitability in practice. The observers, it is pointed out, are acting in an honorary capacity and will depend on their own contacts and upon the goodwill and help of their colleagues for collecting information. It is hoped that all those concerned with the building industry will give them every facility in their effort to serve the best interests of the country.

Coal-Oil Conversion Schemes

In reply to questions on the coal-oil conversion scheme in the House of Commons on Thursday, May 6th, the Minister of Fuel and Power, Mr. Gaitskell, recalled that the coal-oil conversion programme was started in the spring of 1946, at a time when our coal stocks were shrinking, and there was plenty of fuel oil. By June, 1947, however, the oil supply position had changed radically, and it was decided that no more conversion schemes could be authorised. By December, 1947, largely owing to the astonishing increase in American consumption, the world shortage had become more acute, and it became necessary to defer the completion of unfinished schemes which were authorised earlier in the year. Since that time, Mr. Gaitskell continued, there had been little improvement, while the closing of the Haifa refinery had created fresh difficulties. Accordingly it would not be possible at present for all the postponed schemes to come into operation and in the majority of cases the firms must continue to burn coal, probably for some considerable time to come. The only exceptions to this ruling would be, he said, those schemes of conversion which had exceptional economic merit, such as certain cases of steel, glass and pottery production, where the actual process of converting the furnaces to oil burning was nearly completed. The firms concerned would be notified shortly. There would be sufficient fuel oil for those firms which had already converted their plants, and it was to ensure such supplies that the conversion of other plants had been deferred. He had no statement to make about the oil-firing of Bankside power station.

Atomic Energy Developments

It is stated by the Ministry of Supply that the new atomic pile at Harwell is expected to come into operation this summer, when a larger number of radioactive isotopes, with greater strength, will be produced than at present with the low-energy experimental pile. The increase in production will, it is estimated, be sufficient to meet the demands for radioactive isotopes of all research workers throughout Great Britain. The processing, packing and distribution will be carried out by the Radiochemical Centre at Amersham. Last July it was decided to try and supply isotopes from the Gleep or graphite low energy experimental pile, which was then nearing completion. It began operation in August and by the end of September the apparatus for handling the isotopes had been rushed through the shops at Harwell. As the pile worked up to its rated power of 100kW the production of radioactive isotopes was started. The monthly production of radio-isotope samples reached 120 in number in March of this year. Of that number about one third were used at Harwell, the remainder being distributed to hospitals and research laboratories all over the country. Isotopes of approximately thirty different elements, some of which are very rare, have so far been produced in varying quantities. An important part of the work carried out at Harwell is the design of safe packages, which are sealed in such a manner that, in the event of an accident to the carrying vehicle, no radioactive material will be released. It is pointed out that the production of isotopes, although still on a small scale, is noteworthy for the fact that it is an example of the practical uses to which recent discoveries in nuclear physics can be applied, and which are wholly beneficial to mankind.

Graphical Methods for Flow-Net Diagrams

By S. LELIAVSKY BEY, Ph.D., M.I.C.E., M.A.S.C.E.*

No. I

FLOW-NET diagrams have of late developed into rather a popular feature of advanced civil design, for they supply a convenient and easy means for picturing and studying a number of fields which are encountered in various branches of modern structural engineering. Trajectories of principal stress-intensities and seepage in granular dam foundations are possibly among the most frequent and spectacular applications of the method. The critical points of the field, in which stress or flow concentrations

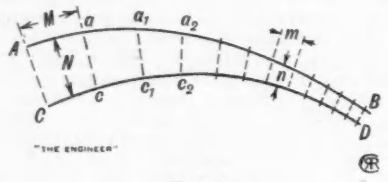


FIG. 1

occur, are clearly indicated in such diagrams as regions of a close spacing of curves, while the slope of the curves gives, at once, an excellent idea and exhaustive information about the direction of the forces or velocities thus investigated.

The process of computation of such diagrams in the office meets, however, with certain difficulties, which explains why modern authors recommend experimental methods (glass tank method or electrical analogy principle) as the easiest and most straightforward solution of such problems. When for reasons of time or economy this procedure is precluded and the designer is *nolens volens* forced to use his slide rule and compass box as the only tools at his disposal for drawing a flow-net diagram, he may either follow the theoretically precise, analytical solution, or employ the approximate, graphical method.

Except in a few elementary cases, the analytical method lies beyond the mathematics of the practising designing offices.

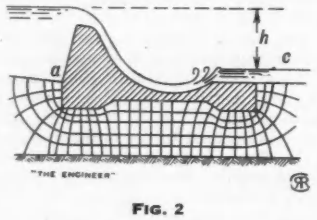


FIG. 2

It is therefore only natural that preference should be given in such offices to graphical computation (Forchheimer's method), which, depending on the conditions of the problem, takes either the form of an entirely independent, self-contained solution, or is used as an auxiliary method for interpreting or interpolating the results obtained by means of model tests.

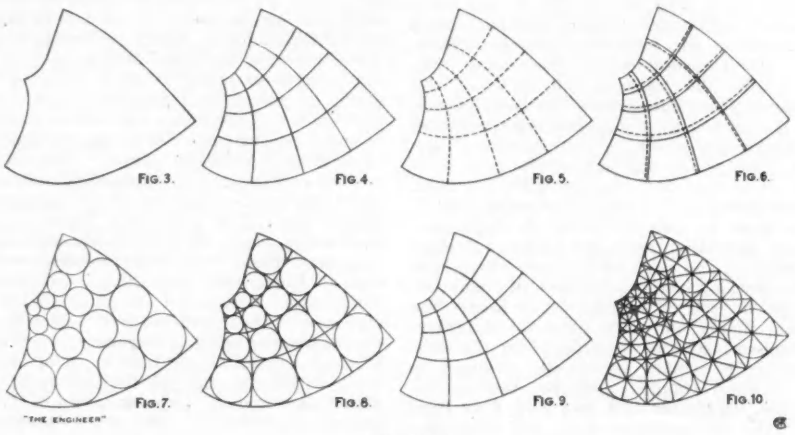
This article presents new improvements in such graphical solutions, which, while simplifying the computation, will also contribute in making the basic criterion more rigid.

FORCHHEIMER'S METHOD

Forchheimer's solution may be described as a trial-and-error method, tending at systematising the intuitive drawing of stream-lines, and thereby reducing the effect of the personal equation in the analysis of seepage-flow problems.

Let A B and C D in Fig. 1 be two stream-lines, and let A C, $a\,c$, $a_1\,c_1$, $a_2\,c_2$ be a series of lines of constant head, or "equipotentials." The latter are supposed to be arranged in such a way that the head lost in between each pair of consecutive curves is always the same. Further, it is also supposed that in drawing the lines A B and C D the distance M was chosen equal to N, so that the figure $A\,a\,c\,C$ represented an "approximate square." Forchheimer shows that in this case for any other two lines of constant head the distance m will also be equal to n, which means that we obtain a diagram consisting of a chain of approximate squares.

He then proceeds to explain his method by means of the sketch reproduced in Fig. 2. This is supposed to be a section of a weir



FIGS. 3–10

built on a porous foundation with an impervious substratum at a certain depth below bed level. The upper flow line ($a\,c$ in the figure) is drawn freehand following approximately the sectional outline of the apron. All sharp angles are, however, rounded out and the general shape of the line is therefore more smooth than that of the apron. The space in between the line thus drawn and the apron is then divided in sections in such a way that the width of each section is approximately equal to its height. These sections can therefore be described as "approximate squares." Under each of these original squares a new square is then built. The outer sides of these new squares will form the second line of flow. The process is repeated until we reach the bottom of the permeable layer. The last line must coincide with the rock surface; this serves to check the assumed alignment of the first curve. In the majority of cases the first trial will not be found satisfactory, and it will therefore be necessary to rearrange the diagram, maybe several times.

The method as it stands can be applied when the depth of the permeable strata is limited by a bed of impervious material, as in Fig. 2. To check the diagram in the case of unlimited depth, we use the principle that the further from the disturbing influence the smoother must be the curves, and therefore at some depth below the apron, the last flow line must either be a semi-circle or an ellipse, or some such regular figure.

LIMITATIONS OF FORCHHEIMER'S METHOD

Extensive experience with the method, in the author's office, showed that the solution was far from being perfect. In fact, two main causes of trouble were detected. In the first instance, the results depended too much on the initial assumptions, the method being therefore far from satisfactory from the standpoint of practical application, and secondly, the basic criterion was not rigid enough, so that there remained always a doubt as to whether the final result had been, indeed, the best one.

A rather curious fact about the method was that an architecturally minded draughtsman, capable of perceiving the sculptural perfection of a graceful curve, but possessing no mathematical background whatever, was capable of producing better results than a fully qualified engineer, whose attention was naturally concentrated on the analytical interpretation of the diagram. This showed that personal intuition played a large part in the computation of the stream-lines by Forchheimer's method, which meant that the solution failed to achieve its essential objective. On further examination it was discovered that this was due to a too great elasticity of the term "approximate square."

Even in Forchheimer's own diagram the "approximate square" at the sharp corners at either end of the apron had little in common with their ideal prototypes (see Fig. 2). It was, therefore, only natural that engineers who applied the process in connection with other designs were rather embarrassed in correctly interpreting Forchheimer's criterion. For there was very little to go upon in discriminating between meshes that could and could not be assimilated to an "approximate square," the result being that the efforts of an artistic draughtsman were more successful than the results obtained by the scientifically trained analyst.

In order to improve the precision of Forchheimer's general solution, an attempt was made in the author's office to apply a method consisting in superposing, upon the primary diagram, a secondary net of flow lines. This is a well-known solution, based on the principle that the diagonals of the original "approximate squares" must form in themselves a new set of such squares. It appears that this principle had been successfully applied by other authors, in the analysis of

* Director, Designing Service, Reservoirs and Nile Barrages, Ministry of Public Works, Cairo, Egypt.

various fields,† but in so far as seepage under dams was concerned, the writer found that the utility of the method had its limitations.

In a few instances in which the primary flow lines possessed only local imperfections the superposition of a secondary net of curves helped indeed to improve the results. On

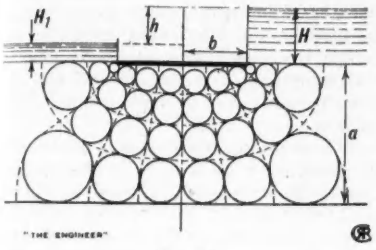


FIG. 11

the other hand, in all cases in which the basic structure of the first diagram was at fault, the secondary curves were of little use, for they supplied no indication as to the source of trouble, and gave, therefore, no useful information regarding the corrections to be introduced into the new computation in order to improve the original network.

On the whole, after many trials, the introduction of a secondary set of curves proved more in the nature of a burden than an asset so long as there was no general axiomatic principle, upon which either of the two flow-nets could be based.

Recommended Solution

It followed that in order to improve the method and obtain better results from the original computation, the attack had to be centred on the source of trouble, i.e., the lack of precision of the term "approximate squares." From the various more precise definitions of the concept the author investigated, the following gave the best results—four curves which intersect at right angles and are all tangent to a common central circle.‡

The chief advantage of this definition was that a very precise, ideal figure, namely the circle, was substituted for the rather nebulous conception of an "approximate" square. It resulted not only in straightening out the process followed in computing the stream-lines, but showed also whether such lines could or could not be computed for the specific conditions of the particular case considered—a point which seemed to have been overlooked in some of the earlier works on the subject.

† Cf. Kulka, "Der Eisenwasserbau," Vol. I, Berlin, 1928, page 35 and following.

‡ Since writing this paper and while reading the proofs the author has come across a similar method of treatment in a German work, "Technische Stromungslehre," by Eck, 2nd Edition, Berlin, 1944.

The better to explain the substance of the proposed alteration, attention is called to Fig. 3. Here we have four lines, which are supposed to delimit the field investigated. Had the old method been used, we might have drawn an infinite variety of flow-nets—for instance as in Figs. 4 and 5.

Judging by the old standards, both diagrams might have been classified as equally good. It will, however, be apparent from a reference to Fig. 6, in which the two figures are superposed, that the term "equally bad" might have also been applied in referring to their relative merits; for the two systems did not coincide, and there was no independent standard which could be used as a common basis in comparing their advantages.

The suggestion which consists in employing circles instead of squares is shown in Fig. 7. In Fig. 8 smooth curves are drawn through the points of contact of the circles, while in Fig. 9 the circles are omitted, and the diagram appears therefore in its final form. In Fig. 10 the computation is verified by two additional flow-nets. This, of course, is optional. It follows that the backbone of the method consists in the use of the auxiliary circles; when they are drawn the rest is elementary.

While it is, of course, true that a graphical computation can never be ideally perfect, since in carrying it out in practice, pencil lines are necessarily substituted for theoretical curves, it will, nevertheless, be realised that there is one and only one combination of sixteen ideal tangent circles which can form a regular pattern, filling entirely the whole area enclosed by the four curves, in Fig. 3. The circle method is therefore mathematically precise, which means that any degree of exactitude may eventually be achieved by the simple expedient of increasing the scale of the drawing. In this it differs essentially from its original prototype, for the lack of precision of Forchheimer's method was a characteristic inherent in its mathematical basis, i.e., the "approximate" square. It is also clear that for a very irregular outline the computation of a network of cotangent circles might be an impossible problem, which will reveal the existence of "pockets," viz., zones in which seepage flow is almost nil.

A few instances illustrating the application of the method to specific seepage problems will now be given.

Comparison with Theoretical Curves

The first question which naturally arises in examining the merits of an approximate method is as to how it compares with the precise mathematical solution of the same problem. A number of cases were therefore selected, for which Pavlovsky § had given analytical flow-net diagrams, and a comparison was made with the circle method.

The cases illustrated are:—

(*a*) *Flat Foundation Under a Barrage.*—

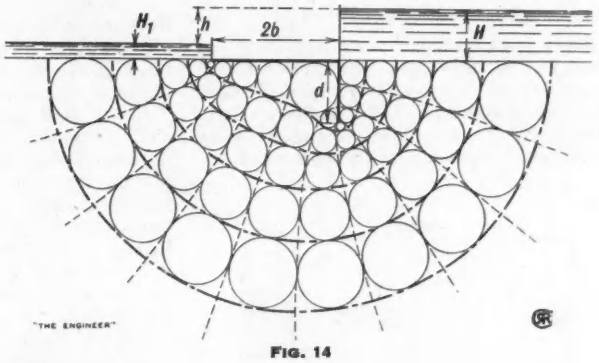
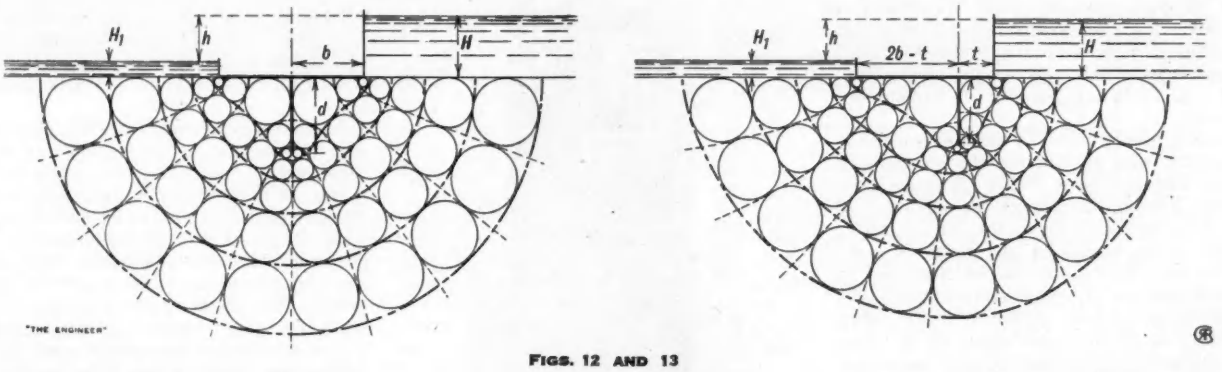


FIG. 14

This is shown in Fig. 11. The analytical net of curves and the system of circles are superposed in the same drawing, and the two principles are found to be fully in agreement.

(*b*) *Same as* (*a*) *but with a Cut-off in the Middle of the Floor, and No Impervious Substrata.*—The superposition is performed in Fig. 12 and the result is again entirely satisfactory.



FIGS. 12 AND 13

(*c*) *and* (*d*) *Cut-off Shifted to the Left and at the Upstream End of the Apron.*—As seen from Figs. 13 and 14, the coincidence of the circles with the theoretical curves is again faultless.

It is therefore obvious that provided the circles are accurately drawn the solution will give results fully acceptable for practical purposes; which means to say that the degree of accuracy depends entirely on the designer's will.

(To be continued)

Tasmania Government Railways.—A board of inquiry has been established to investigate the system of administration, control and finances of the Tasmania Government Railways. Mr. W. D. Chapman, Director of Civil Engineering, Australian Commonwealth Transport Department, will act as chairman of the board.

§ M. N. Pavlovsky, "Theory of the Underground Movement of Water Beneath Hydraulic Structures, and its Main Practical Applications," Petersburg, 1922 (in Russian); Figs. 20, 31, 32 and 33. See also "Proceedings," First Congress on Large Dams, 1933, Vol. IV, Paper 36, by M. N. N. Pavlovsky, "Motion of Water Under Dams" (in English).

The British Industries Fair

No. III—(*Continued from page 443, May 7th*)

WE continue below our description of some of the more novel and interesting exhibits at Castle Bromwich, Birmingham.

Metropolitan-Vickers Electrical Company, Ltd.

Steam turbine supervisory equipment, as displayed on this stand, was developed and manufactured by the Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester, 17, for indicating and recording certain measurements on turbines which are

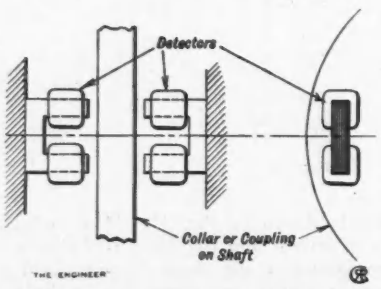


FIG. 15—DETECTOR ARRANGEMENT FOR AXIAL EXPANSION MEASUREMENT—M-V.

of particular importance during running-up and shutting down periods.

Two kinds of measurement can be made by this "Turbovisory" equipment: first, the differential expansion between rotor and cylinder, which may be a serious matter in modern plant designed for high steam conditions, and, secondly, the rotor shaft eccentricity which may occur in the h.p. and i.p. cylinders because of unbalanced heating.

Briefly, the problem of axial expansion is associated with an inherent characteristic of steam turbines—that higher operating conditions involve an increase in the mass of the cylinder relatively to that of the rotor. Under such conditions the rotor is more liable than the cylinder to be subjected to sudden changes of temperature. Over-rapid axial expansion between the rotor and cylinder may cause axial interference at the blading or glands and, in starting, such expansion must be kept within definite limits by heating

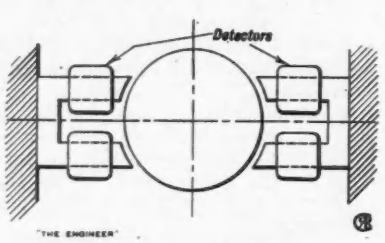


FIG. 16—POSITIONS OF DETECTORS FOR ECCENTRICITY MEASUREMENT—M-V.

the cylinder concurrently with the gradual and uniform heating of the rotor.

Measurement of the relative axial expansion can be made between a point on the shaft and an adjacent portion of the cylinder at the end remote from the thrust bearing, which is at the high pressure end of the shaft. Accordingly, this measurement is made by detectors in the form of two bridge-connected electromagnets rigidly fitted to the turbine cylinder, one on each side of the coupling (Fig. 15) or any other suitable steel disc rotating with the shaft. The air gaps between each magnet and the disc are made equal under static conditions, and any differential axial expansion will change the air gaps causing a corresponding out-of-balance current to flow in the bridge circuit. This out-of-balance current is amplified electronically to actuate a recording equipment giving on a roll chart a continuous record of the expansion.

Rotor shaft eccentricity, like differential axial expansion, can arise from unbalanced heating during starting up and can cause serious vibration and damage, unless the fault is checked by admitting a small steam flow to the cylinder simultaneously with the barring round of the rotor.

Eccentricity is usually measured on a portion of the shaft near the extreme high pressure end, using a method similar to that described above for axial expansion, the main difference being that an oscillator feeds two electromagnets mounted diametrically opposite on the turbine shaft (Fig. 16).

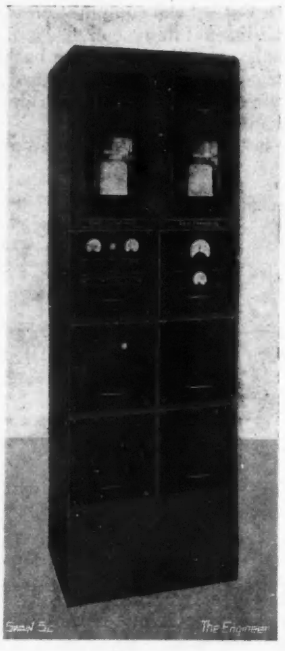


FIG. 17—TURBINE SUPERVISORY EQUIPMENT—M-V.

Equal air gaps are left between the shaft and the pole faces of each detector unit. Any eccentricity of the rotor shaft in the h.p. or i.p. cylinder caused by unbalanced heating creates a difference in the air gaps and modulates the 500 c/s output of the oscillators. The modulated signal is amplified electronically, converted into direct current, and made to actuate a continuous recording instrument.

Both sets of apparatus, for measuring axial expansion and eccentricity, are housed in a common cubicle (Fig. 17), built up of racks sliding on runners so that each unit can easily be removed for inspection or maintenance. These units comprise a power pack and oscillator, an amplifier and axial expansion network in a common cubicle and a duplex recorder with two indicating instruments. The cubicle is made of sheet steel and stands on resilient supports to prevent floor vibration affecting the operation of the recorders. A synchronous motor drives the 3½in roll charts at 3in per hour. The complete equipment is run continuously and has a consumption of about 250W from the a.c. mains.

To complete the equipment there are the two sets of detectors, which are mounted on the turbine, and junction boxes are supplied so that the supervisory cubicle can be situated away from the turbine and connected to it by cable run through conduit laid in the floor.

Each recording equipment is calibrated in the company's laboratory. The range of relative displacements covered is ±0·2in, indications on one side of the centre-zero chart representing an expansion of the rotor relative to the cylinder and, on the other side, an expansion of the cylinder relative to the rotor. For eccentricity measurements, full-scale deflection of the recording instrument corresponds to a shaft eccentricity of 0·015in, and the eccentricity recorded is the radius of the eccentric circle measured at that position of the shaft where the detectors are placed.

Other exhibits on the same stand include a range of equipment designed for the supervision and control of maximum demand with the aim of reducing the consumers power costs and the peak load on the system. There is also a model of the 2000-kW gas-turbine that is being built to drive an alternator in the company's own power station at Trafford Park.

Brush Electrical Engineering Company, Ltd.

The main exhibit shown by the Brush Electrical Engineering Company, Ltd., Loughborough, is representative of this firm's new range of axial flow turbines and consists of the steam end of a turbo generator set.

In this range of standardised back pressure units which have been designed to meet the requirements of industries using process steam, all the turbines are of similar design. For any given output the length will depend upon the number of stages required to suit the specified steam conditions. To achieve high efficiency the blades are of vortex design. The diameter of the blading is kept small, so that, to pass a given quantity of steam, the blades themselves must be relatively long. In this way it is claimed that these turbines with their small outputs can be made almost as efficient as much larger units.

In the form exhibited the turbine can be used for outputs up to 3500kW when supplied with steam at 400 lb per square inch with a back pressure in the region of 15 lb per square inch. Under these conditions nine stages are used. The speed of this set, 10,000 r.p.m., cannot be regarded as unduly high because, owing to the small diameter of the rotor the blade peripheral speed is no higher than has been customary for some years.

Among the switchgear exhibits on this stand is a "power centre" or distribution unit suitable for medium sized factories. This exhibit is a typical example, units of which consist of an incoming h.v. control panel for the primary side of the transformer, together with l.v. fuse-switch distribution gear; if required, an l.v. control panel can be included. The units are built up by enclosing the equipment in sheet metal cabinets with flush-fronted panels, as shown in Fig. 18.

The h.v. panel on the right of Fig. 18 houses a vertical drawout unit, which is

available in ratings up to 600A at 11kV and breaking capacity ratings up to 250MVA. Air spaced, fully insulated bus-bars and connections are used and manual, spring, or solenoid closing mechanisms can be incorporated.

As illustrated in Fig. 18, the l.v. distribution equipment occupies the central and left-hand panels, and comprises an assembly of high rupturing capacity fuse switches. These fuse switches are normally arranged to form six circuits per panel to replace the older form of cast iron fuse switch assemblies which are usually mounted above and below a central bus-bar chamber. In the particular equipment illustrated, only nine l.v. circuits were required. Six of these were provided by the central panel and three by the left-hand panel, leaving blanked-off spaces for three additional circuits, if required. Fuse switches for these equipments can be supplied in ratings of 60A, 150A and 300A, triple pole or triple pole and neutral, with the neutral always switched.

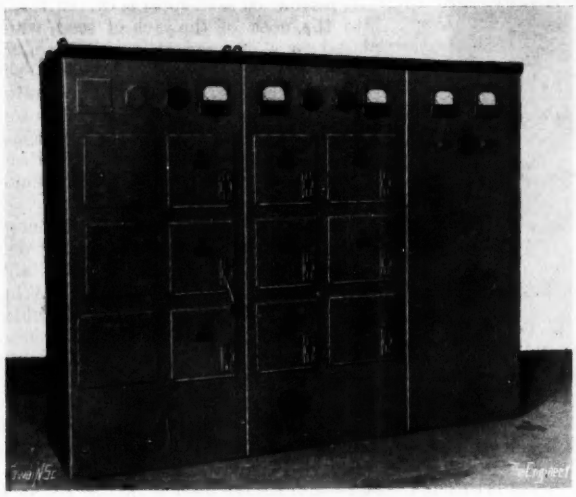


FIG. 18—POWER DISTRIBUTION CENTRE—BRUSH

When fitted, the l.v. control panel comprises a stationary cubicle with oil circuit breaker and isolating switches; the cubicle being designed to match, in size and appearance, the h.v. and distribution panels. Alternatively, l.v. vertical drawout units are available to line up with this class of switchgear, in standard ratings of 1000A, 2000A and 3000A, with interrupting capacities up to 40,000A.

STEELS ENGINEERING PRODUCTS, LTD.

A new 12½-ton capacity mobile crane, shown in Fig. 19, is on view on the outdoor stand of Steels Engineering Products, Ltd., of Derby. It forms an addition to the range of Coles cranes built by this company and is one of the biggest to be built in mobile form. Our illustration shows the crane with an 80ft jib. With a standard 30ft jib the crane is designed to lift a maximum of 12½ tons at 10ft radius, with outriggers in position. Fully mobile, without outriggers, it will lift 8½ tons at 10ft radius.

The crane has four motions; hoisting, derricking, slewing and travelling, each operated by separate electric motors. The motors are supplied with d.c. by a variable-speed generator directly coupled either to a Ford V 8 petrol engine or a Perkins P 4 oil engine, as preferred. This power unit is mounted on the superstructure, whilst the whole crane travels on a carriage fitted with six pneumatic-tyred road wheels. The superstructure can be turned full circle in either direction, and steering and all other operations are controlled from the driver's seat on the revolving superstructure.

The electric motors, of B.T-H. manufacture, are rated at 12 h.p., 6 h.p., 2 h.p. and 12 h.p. for hoisting, derricking, slewing and travelling motions, respectively. They are specially designed for crane service and have exceptionally large diameter shafts. Self-resetting limit switches prevent overwinding and overlowering on the hoisting motion, and prevent overderricking.

Control is simple. Speed is controlled by the engine accelerator pedal. The controller for the desired motion is selected and the handle moved either forward or backward whilst the engine is running at idling speed. Thereafter, the accelerator is used to regulate speed as required. Any of the four motors may be switched in by moving the appropriate handle, the motor being directly connected without interposing rheostats or relays. When switched in at reduced engine speed, the voltage generated is not sufficient to move the motor, but on increasing the engine speed the voltage is sufficient to release the electromagnetic brake concerned. Should it be desired to bring into operation an additional motion whilst one is already in use, the accelerator pedal is momentarily released, and the further motion or motions are switched in, and the engine again accelerated. When the accelerator pedal is released, all motors stop and all electromagnetic brakes are automatically applied.

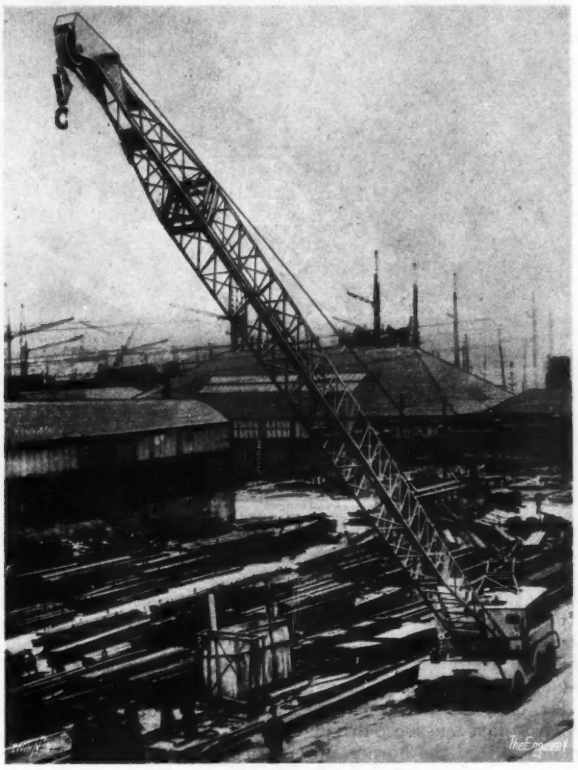


FIG. 19—12½-TON MOBILE CRANE—STEELS ENGINEERING

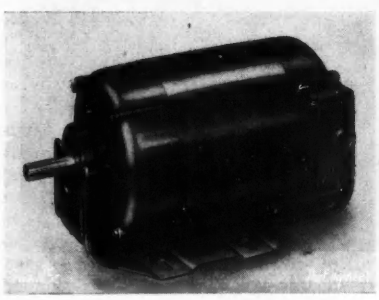


FIG. 20—F.H.P. MOTOR IN RESILIENT MOUNTING—BROOK MOTORS

BROOK MOTORS, LTD.

In the absence of sufficient stand space to show advantageously its complete range of products, Brook Motors, Ltd., Huddersfield, are concentrating attention on fractional horsepower motors. Accordingly, the full range of "Cub" f.h.p. motors is being exhibited in a display which includes single-phase, capacitor motors, as well as two and three-phase motors, protected and totally enclosed, with outputs ranging from ¼ h.p. to ¾ h.p.

Among these exhibits is a recent addition to this range—the "Cub" f.h.p. motor, with resilient mounting, which forms a suitable unit for refrigerators, domestic machines and industrial drives where silence is important and for delicate machinery where vibration is undesirable. This motor is mounted in a pressed steel cradle, which conforms to the same mechanical fixing dimensions as the standard frame with feet. The stator end shields are cast with special bosses designed to take the bonded rubber suspension units mounted in both arms of the cradle, as shown in Fig. 20.

WELDALL AND ASSEMBLY, LTD.

Stands taken by Weldall and Assembly, Ltd., of Eyre Street, Birmingham, 18, display representative products, including fractional horsepower electric motors, examples of fabrications illustrating the firm's welding methods and domestic kitchen units. On an outdoor stand an exhibit of considerable interest to agricultural engineers is the firm's "Dryall" mobile grass-drying plant. As illustrated in Fig. 21 the complete plant can be hauled by a single tractor from farm to farm on two trailers.

Present economic conditions prohibit the importation of sufficient concentrated feeding stuffs for cattle, and hence the conservation

of protein in summer grass is now of much importance to the nation and to farmers. One efficient method of conserving the protein is to dry grass, instead of making it into hay, and the "Dryall" plant has been designed to meet the demand for an economical grass-drying machine.

When assembled for use, as shown in Fig. 22, the plant forms a compact outfit. On the trailer to the left of the illustration is an oil-fired furnace, connected to a rectangular air chamber. The burner, with its oil and air supply pipes, may be seen. At the far end of the air chamber (Fig. 21) is a pair of fast and loose driving pulleys, an oil pump to feed the burner, an oil-injection blower, and, within the air chamber itself, a large centrifugal fan. Power for this part of the equipment may be supplied by a belt from the power take-off of a farm tractor, or by electric motor, if preferred.

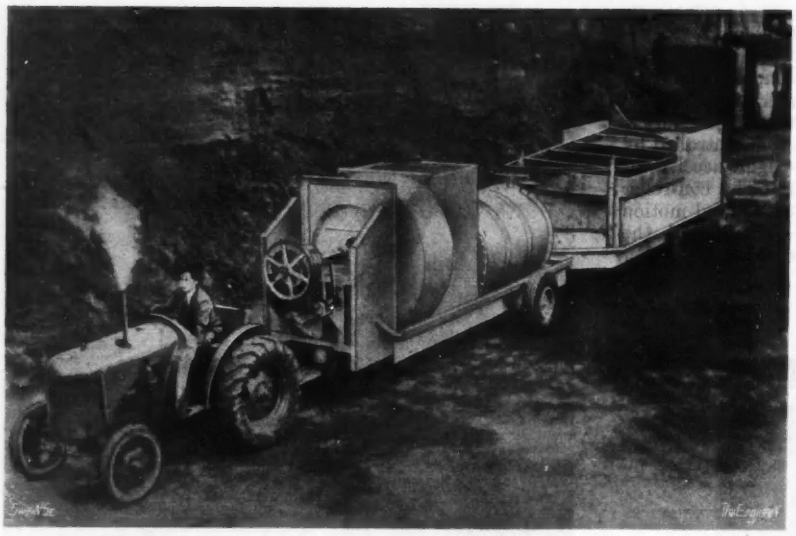


FIG. 21—MOBILE GRASS DRYING EQUIPMENT—WELDALL

The second part of the equipment, comprising the drying chamber and grass turntable, when in use is arranged as shown in Fig. 22 at right angles to the first part and connected to it by a pair of sheet metal detachable ducts, for hot air to flow to the drying chamber and for pre-heated air to flow to the air chamber for further heating. A circular turntable is divided into halves, so that one-half is within the drying chamber whilst the other is outside, as shown. The floor of the turntable is perforated, as is the roof of the drying chamber. Above the roof plate of the drying chamber are fitted low side plates, so as to form a large tray to receive the grass which is to be dried.

The cycle of operations is as follows:—Grass is received on the top tray whilst the previous batch of grass is within the drying chamber, occupying the half of the turntable out of sight in the photograph reproduced. Hot air passes through the grass within the chamber and part of it flows upwards through the new batch of grass, thus pre-heating it and driving off some of the moisture. The remainder of the air, together with fresh air, is recirculated through the air chamber. After a period, according to the amount of moisture in the grass, the new batch of grass is pushed over the side of the tray, as shown, into the empty half of the turntable; the turntable is revolved through 180 deg., thus putting the new batch within the drying chamber and putting the previous batch, now completely dried, out in the open for removal. The sides of the turntable are easily removable in sections, and the sheet dividing plate is equipped with a light wire link "chain." By removing a section and pulling on the chain, all the dried grass can be pulled off the turntable and away from the plant. The plant is then ready for a new cycle of operations.

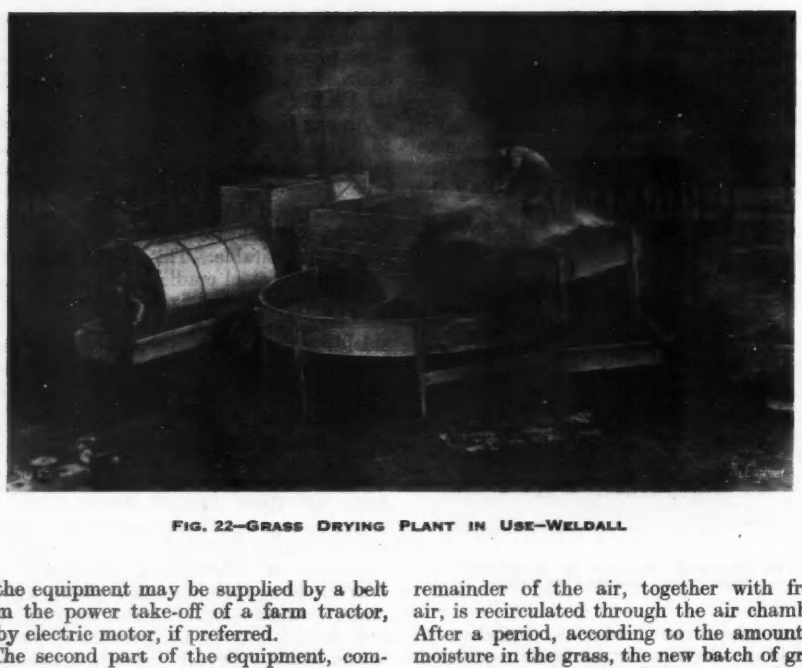


FIG. 22—GRASS DRYING PLANT IN USE—WELDALL

It is claimed that the unit will produce 24 cwt of dried grass per eight-hour day when the water ratio of the grass is 3½ to 1. Fuel consumption is stated to be 8 gallons per hour.

FERRANTI, LTD.

An interesting application of electrical engineering in agriculture is the Ferranti-Jeans seed conditioner, seen on the stand of Ferranti, Ltd., Hollinwood, Lancs. This seed conditioner is a motor-driven machine, designed for drying all classes of seed without removal from the sack.

A perforated sack spear is driven vertically into the neck of the sack of seed, which is placed in a convenient position under the wall-mounted conditioner. The sliding collar on the air outlet of the conditioner is then pressed firmly over the top of the sack spear. On starting up the machine warm air is blown through perforations in the spear, and through the seed, removing both surface and internal moisture.

The Ferranti-Jeans seed conditioner embodies an 0·4 h.p. single-phase motor, driving a blower giving 400 cubic feet of air per minute. This air is heated by a 5-kW heater controlled by a 30-A contactor, which is actuated by a bellows thermostat situated in the air stream. In this way the air temperature is accurately controlled and may be adjusted up to a maximum of 120 deg. Fah. by the dial on the front of the conditioner.

A varied display of a.c. and d.c. meters and meter testing equipment on the same stand includes an improved form of "F L" single-phase credit, or quarterly meter, which can be supplied either with clock or with cyclometer dials. This meter is available in a cast iron case fitted with moulded Bakelite, pressed aluminium, or Ferranti "Nomag" non-magnetic cast iron covers. Improved designs of low load and inductive load adjustments, which simplify calibration, are incorporated.

Clock or cyclometer dials are also available on the new d.c. credit or quarterly meter, type FK, which owes its small size and improved low-load performance to the use of an anisotropic high energy permanent magnet.

(To be continued)

D.F. EQUIPMENT FOR SPANISH AIRPORTS.—As part of a scheme to bring her airport equipment completely up to date, Spain has ordered modern direction-finding apparatus from Marconi's Wireless Telegraph Company, Ltd., Chelmsford, Essex. The latest order covers the supply of two new very high frequency direction finders and two high frequency direction finders. It is understood that this equipment, together with other apparatus already supplied by Marconi's, will be installed at Madrid, Barcelona, Seville, Bilbao, as well as other new airports. The v.h.f. equipment to be supplied to Spain is unique in being capable of remote operation from distances of up to about 30 miles over normal telephone lines, while the equipment itself is left unattended on the site. The aerial system is capable of providing d.f. information on as many as four different frequencies simultaneously, using separate receivers and display units for each frequency, thus enabling the positions of as many as four aircraft to be fixed at the same time and displayed independently. Instantaneous visual indications of the bearings are given on the appropriate cathode ray tube.

Machines for the Blind

By M. DU-PLAT-TAYLOR, M.I.C.E.*

BEFORE the eighteenth century no attempt was made to educate the blind or to provide any means which would enable them not only to read, but to obtain any gainful employment. The poorer blind persons wandered about begging.

During that century, however, embossed lettering was produced for the use of the blind, which enabled them, by tracing out each letter independently, to read in a very slow way. In 1784 Valentin Haüy established the first school for blind children in Paris. Haüy employed lettering of the italic character, of a large size for beginners and smaller for advanced readers. Many forms of embossed lettering were later devised, intended to make tactile reading easier and quicker. In 1834 James Gall devised a system of angular characters which was claimed to be easier to read than normal lettering with curved outlines. On the other hand, John Alston in 1840 produced embossed books with large roman letters and figures. All these systems were very slow, requiring the words to be spelt out, with the fingers, letter by letter.

The first attempt at a departure from the ordinary alphabet was that of Thomas Lucas, of Bristol, who invented in 1837 a system consisting of arbitrary simplified characters resembling those used in shorthand. Lucas was the first inventor to adopt contractions, special signs being employed for combinations such as "th," "sh," "ng," or "wh." In a report of the London Society for Teaching the Blind to Read, in 1853, Lucas's system is referred to as follows :—

"The stenographic system, by contracting words into so small a space, enables the fingers to pass rapidly over a sentence and thus bring a complete idea within the compass of a thought, so as to enable the blind person to read with the same enjoyment as a person who possesses the blessing of sight."

For some years there was a competition between Alston's and other systems using ordinary lettering and the arbitrary system of Lucas, the unfortunate result being that those persons trained in one form were unable to read books printed in the other.

Another system was that of William Moon, who was born in 1818 and became blind in 1840. In Moon's system, unlike Lucas's, many of the characters were based on the ordinary alphabet, but others were of an arbitrary character. Moon's is the only one of the earlier systems which survives to this day, and is used side by side with Braille. Though the speed of reading is much lower than that of Braille, Moon is more easily learned by those who become blind late in life, and books in this embossed type are in steady but limited demand. The present-day Moon alphabet, numerals and contractions are shown in Fig. 1. The lines read alternately from left to right and right to left, the fingers being guided from one line to the next by the guide signs.

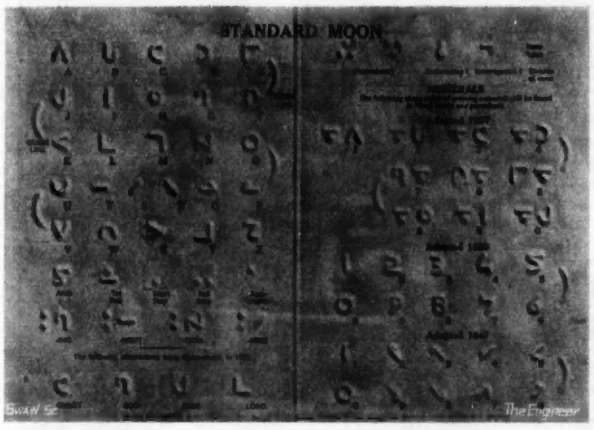


FIG. 1—MOON ALPHABET

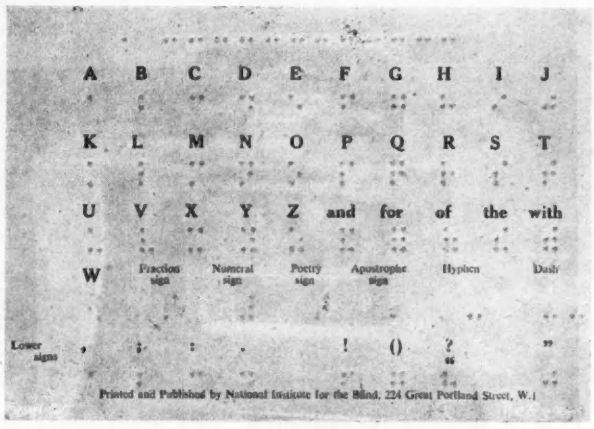

A B C D E F G H I J
K L M N O P Q R S T
U V X Y Z and for of the with
W
Fraction sign
Numeral sign
Poetry sign
Apostrophe sign
Hyphen
Dash
Lower signs
Printed and Published by National Institute for the Blind, 224 Great Portland Street, W.1

FIG. 2—BRAILLE ALPHABET

The Moon Society, which is now incorporated in the National Institute for the Blind, produces books at a small factory in Brighton. Brass type is used, set up by blind and sighted compositors in the ordinary way, and impressed on damped, stout paper by printing presses of the ordinary type. The production in 1947 was 3230 volumes.

All the systems hitherto described, except Moon, have been superseded by Braille, in which the characters are formed by combinations of dots. Louis Braille was born at Coupvray, near Paris, in 1809, and became blind at the age of three. He entered the Institution des Jeunes Aveugles in Paris and became, in course of time, a junior master there. The system in use in the school was that of Valentin Haüy, mentioned above, and Braille set himself to devise some system which would be an improvement upon it. He early found that the tactile reactions to a series of dots were more rapid than to lines, and his system was based upon this, his alphabet being composed of cells consisting of groups of dots in three horizontal rows of two. Sixty-three combinations are possible, and forty-five are used in the standard Braille shown in Fig. 2.

The sheets of paper are embossed on both sides and may be either interlined or interpointed. In the case of interlining the lines embossed on the reverse of the page are between those embossed on the front, the spacing between centres of corresponding dots and adjacent characters in adjacent lines being 0·5019in. In interpointing the characters embossed on the reverse of the page are interpolated between those embossed on the front, the spacing between centres of corresponding dots in adjacent characters in adjacent lines being 0·4107in. It will be seen that a great economy of paper is effected by interpointing.

A standard Braille page in interlining has eighteen lines of thirty-six cells, and in interpointing twenty-eight lines of thirty-six cells. The dots are 0·065in diameter and 0·028in high, and are spaced 0·1in apart vertically and 0·09in horizontally in any character.

The advent of the Braille system, when it became generally adopted, was a great improvement in the amenities for the blind, since not only could it be much more speedily read than any previous system, but it was possible for the blind to write it. Writing could be done by hand by means of simple perforated frames and hand styles, and later by means of the machines described below.

Machines consist of (*a*) hand-operated portable machines in the nature of typewriters, and (*b*) power-operated machines for producing books, periodicals, maps and drawings in quantity.

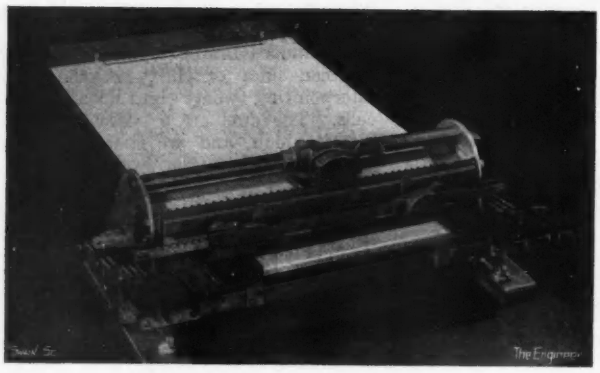
HAND-OPERATED MACHINES

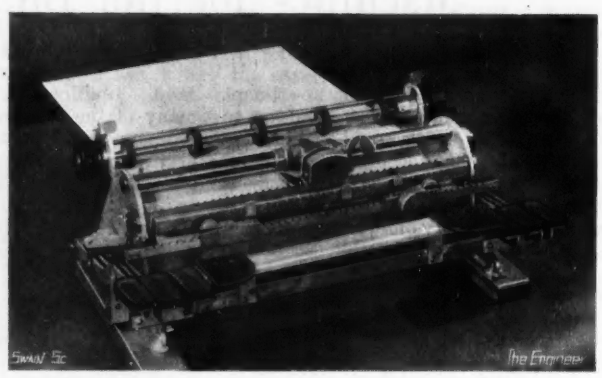
As an example of these it is proposed to illustrate the Pyke-Glauser hand-transcribing machine (Figs. 3 and 4) and the shorthand machine (Fig. 9). The Pyke-Glauser machine is extensively used by voluntary sighted workers in rendering into Braille books for the libraries for the blind and by blind persons for their own correspondence, and also in schools for the blind, and, in fact, for all purposes for which more than one copy is not required. It embosses Braille on single sheets of stout paper which are attached by a metal holder with positioning pins, to an aluminium folding table. Line shift is arranged by removing the paper holder pins from one pair of holes and inserting them in the next pair. On completion of the front of the page, the paper holder is reversed and the back of the page embossed. Provision is made in the line spacing for either interlining or interpointing. Fig. 3 shows the machine arranged for working, with the table and paper holder, for interlining or interpointing. For correspondence or notes embossed on one side only and thus not requiring accurate registration, an alternative roller feed is provided, similar to that on an ordinary typewriter. Fig. 4 shows the machine set up with the roller feed.

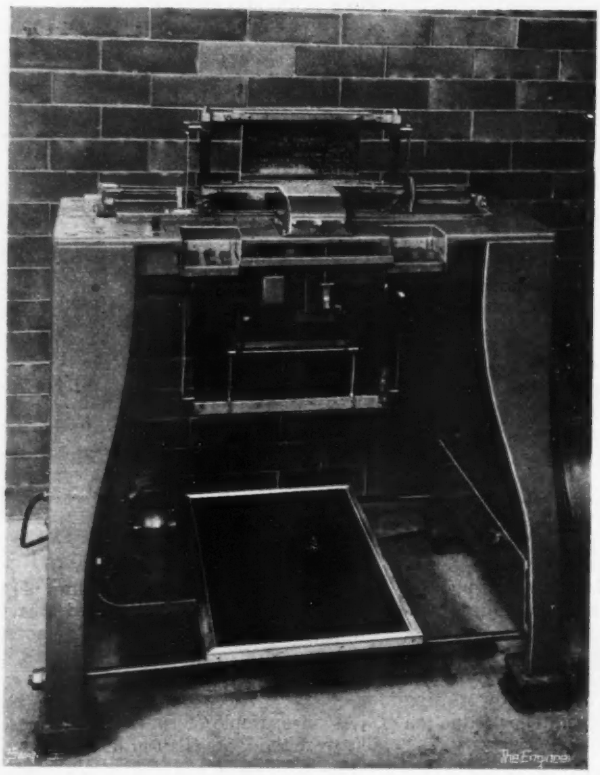
The punching or embossing is done upwards from beneath the paper, so that the writing done can be read by a blind operator whilst

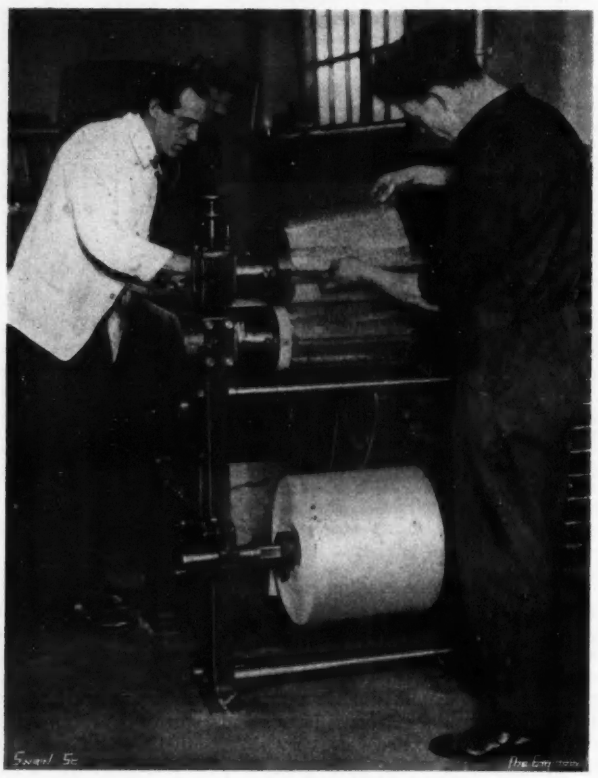
* Hon. Consulting Engineer to the National Institute for the Blind.

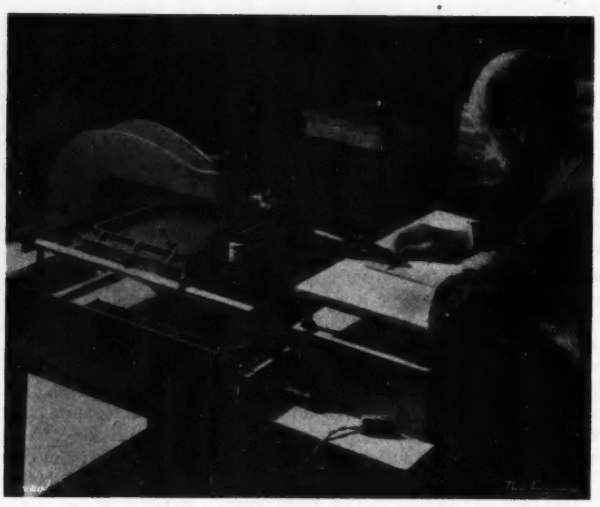
MACHINES FOR THE BLIND











FIGS. 3 AND 4—PYKE-GLAUSER HAND-TRANSCRIBING MACHINE

FIG. 5—STANDARD TRANSCRIBING MACHINE

FIG. 6—ROTARY PRESS

FIG. 7—TRANSCRIBING MACHINE IN USE

FIG. 8—MAP-MAKING MACHINE

working. It is operated by six keys, three on the left and three on the right, each key corresponding with one of the dots in a cell. Hence, unlike a typewriter, anything from one to six keys have to be depressed simultaneously, as striking a chord on the piano. There is a space bar between the keys. The styles or punches are fitted in style bars operated by the keys, and work against a pit plate fixed in a cantilever arm. The touch in the latest pattern of this machine is very light and all the adjustments are made simple and accessible for use by the blind.

A further abbreviation of Braille has been made for use as shorthand by blind typists, and this shorthand is embossed on paper strips by the use of the shorthand machine shown in Fig. 9. This is a small easily portable machine. When dictation is finished the embossed strip is taken to the typewriter where the blind typist reads the shorthand, memorises passages and then types it.

Mechanically Operated Machines

For the production of books and periodicals, of which many copies are required, transcribing is done upon double zinc sheets from which paper copies are subsequently made in a printing press. Fig. 5 illustrates

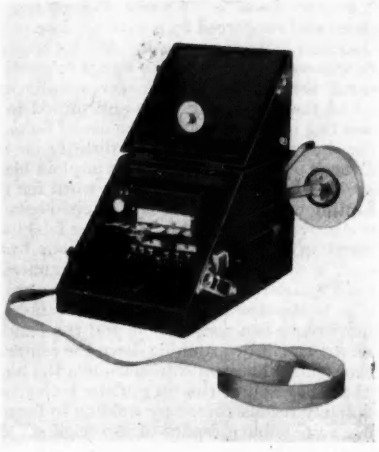


Fig. 9—Shorthand Machine

the standard transcribing machine of the National Institute for the Blind, which is electrically operated. The embossing is done horizontally on to the zinc sheets which are held in a vertical frame, the embossing styles being housed in a stationary unit whilst the carrying frame and zinc sheets move.

The machine is operated by six keys and a space bar similar to those on the hand machines. The machine is capable of being operated at a speed of five cells or letters per second, or 300 per minute. As considerable force is required to emboss the double zinc sheets this is provided by a ¼ h.p. electric motor fitted beneath the table. The impression is effected by moving the counterdie by means of toggle gear, which is connected or disconnected with the continuously running motor by means of a clutch operated by the keys. Depression of the keys move forward the appropriate punches in the style box by means of a wedge mechanism, and then make the impression by the operation of the clutch and toggle gear, and subsequently move the vertical frame one space to the left ready for the next character to be impressed. Line spacing is effected by hand by means of the lever shown on the right. A back spacer is also provided. The touch is very light. These machines have been developed from former types operated by compressed air. They have been supplied by the National Institute for the Blind to foreign countries, including the United States. Fig. 7 shows one of the machines in use, the blind operator being dictated to by a sighted person.

The double zinc plates are united at the top and when embossed are transferred to the printing department. For the production of books the paper sheets are embossed from the zinc on Victoria platen printing machines which have a capacity of 300 sheets per hour. For periodicals such as the *Braille Mail*, *Radio Times*, &c., where large production is required in a short time, a rotary press (Fig. 6) is used. In this illustration one of the zinc sheets is being fitted in the press. The capacity of the machine is 4000 sheets per hour. Stitching and binding is carried out in machines of the ordinary type calling for no special description. The total production of Braille books, &c., in 1947 was 39,483 volumes.

One of the problems of Braille production was the making of maps or diagrams, which had to be impressed on the zinc sheet by hand by the use of a hammer and puncher. This was a very slow process and rendered it impossible to insert maps illustrating, for instance, military operations, in publications such as the *Braille Mail*. Not only are maps required for these publications, but they are used in the schools for the blind, as well as diagrams in connection with Euclid, geometry, physics and architecture.

The hand-punching process has now been superseded by the Du-Plat-Taylor map-making machine shown in Fig. 8, by which the time occupied in producing maps has been reduced to about one-tenth of that occupied by hand punching. This machine consists of two movable frames travelling on roller bearings, in the upper one of which the double zinc sheet is secured. The upper frame travels upon the lower one in a transverse direction, and the lower one travels on the bed of the machine in a lateral direction. The upper frame is provided with an extension arm and pointer which extends over a map table. Every movement of the pointer over the map to be copied, therefore, results in a corresponding movement of the zinc sheets. The machine produces an exact copy of the map to the same scale, and any required reduction or enlargement of the map must be effected by pantograph beforehand. Embossing is effected by a solenoid placed below the zinc sheets, and acting against a counterdie mounted on a cantilever arm above. As various features of maps such as mountains or rivers are indicated by the use of dots of various sizes, provision is made for quickly changing the punches and counterdies. Even spacing between the dots is achieved by means of a thread which unwinds as the carriage moves and so rotates a commutator. The solenoid is energised at each " make " on the commutator. In the illustration the map being generated in dots can be seen.

By the use of this machine it will be possible to supply atlases for the use of the blind, bound up in the same way as Braille books.

There are many items of minor equipment for the blind which are being constantly designed and produced by the Scientific Development Committee of the National Institute for the Blind, and some of these have been invented by blind persons who are members of that Committee; but they do not fall within the scope of the present article.

The Restoration of Coningsby Church Clock

MODERN engineering processes, which are often quite familiar in connection with present-day production methods, sometimes have very unexpected applications in totally different fields of service, and an instance of this is provided by the recently completed restoration of the ancient tower clock in the church of St. Michael and All Angels, Coningsby, Lincolnshire.

This strange old timekeeper claims the distinction of having the largest dial still in existence in England, which indicates the time by a single hour-hand. Clocks of this " one-handed " type were in general use before the middle of the seventeenth century, but with the introduction of the minute-hand, most of them were converted to the two-handed arrangement, and few now remain in their original state. The Coningsby clock, with a dial diameter of 16ft 6in, is the most outstanding of those which escaped alteration. It may have been the large dimensions of the dial which discouraged any change, for, not only would the addition of a minute-hand of such large size have imposed on the mechanism a load beyond its capability, but the extra hand may well have been considered unnecessary, the length of the hour-hand being such that the time to the nearest five minutes can be read without much difficulty.

The mechanism of the clock is quite as unusual and interesting as the dial. The main framework is made up of oak beams, jointed to form a rectangular structure. Spanning these wooden frame members are iron bars, which serve to carry the bearings for the various pivots of the going and striking trains. These bars are secured to the wooden beams by wedges, and in its original state the clock seems to have been without screwed fastenings of any kind.

The original wheels and pinions were all of wrought iron, but a new escape wheel of brass was fitted at some later date, and the pallets are also renewals. The teeth of all the wheels and pinions are hand cut, and careful examination reveals a number of instances where the division was incorrectly made and afterwards corrected. The wheels are of the built-up form, the rims and spokes being made separately and assembled by riveting. Despite the difficulties that must have beset the craftsman who had to obtain truth of assembly with such an arrangement, the wheels are surprisingly accurate.

The pendulum, which is about 15ft long and makes one swing every two seconds, is not hung from a support on the clock frame itself, but is suspended from a separate bracket, mounted on the tower wall close beside the clock frame. The pendulum rod is a flat strip of iron, and the bob a cheese-shaped mass of lead. As the pendulum is so placed that a crutch of normal form cannot be used, a strange horizontal bar, or " connecting-rod," serves as a link between the pendulum and the pallets.

The control of the striking mechanism is by a " locking plate," and an interesting detail of the plate itself is that it is of the internally notched form and is almost identical with those to be seen on the famous West Country clocks at Exeter Cathedral and Ottery St. Mary church. Despite its somewhat crude construction, it controls the number of blows struck at each hour in a very efficient manner.

A rather amusing feature of the barrel on which the weight line of the striking train is wound is that its original diameter has been

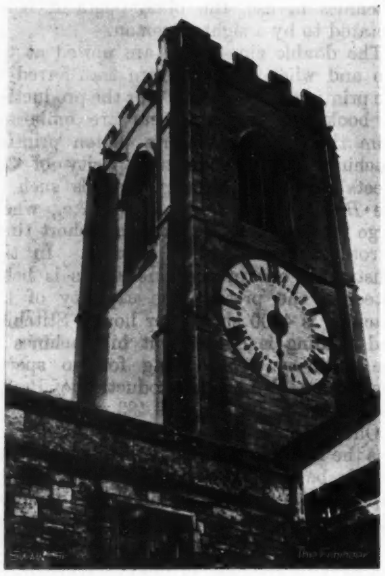
increased by jacketing it with pieces of wood. This suggests that the speed of striking was considered too slow, and that some local mechanic with a knowledge of the moments of forces set out to speed it up by this rather queer method of increasing the power leverage!

After keeping remarkably good time for many years, the clock eventually became so worn that no amount of local repairing was effective. It was then allowed to stop, and after it had been disused for some time a suggestion was made that it should be scrapped and replaced by a more modern timekeeper. This proposal raised considerable opposition, for it was pointed out that the clock was of great value from an antiquarian standpoint. As a result of these objections, expert opinion was sought on the possibility of reconditioning the mechanism. The verdict being favourable, the firm of G. and F. Cope and Co., of Nottingham, was asked to undertake the work.

It was realised at the outset that the matter was no ordinary clock repair, for by all the usual standards many of the parts would have needed replacement, but it was decided that, by the employment of derusting, arc welding and similar processes, most of the mechanism could be saved from scrap.

The main cause of stoppage was found to be loss of impulse, due to wear in the pivot holes of the horizontal connecting-rod linking the pendulum and pallets, but a considerable number of other parts needed attention. The wooden beams of the frame were in very good state of preservation, but all the bushes in the iron bars were much worn and the teeth of most of the wheels were in a bad state. The replacement of the bushes was a simple matter, but the correction of the worn teeth presented a more difficult problem. It was eventually decided that each worn tooth would need to be built up by welding, and subsequently reshaped by hand. This proved a somewhat laborious and difficult task, but it enabled most of the original wheels to be retained. Some other parts, such as detents, hammer levers and so on, also needed to be built up and reshaped at the points where they were worn, in order to restore the correct amounts of lift and clearance.

As a result of carefully effected welding operations, only the striking locking wheel had to be replaced. The new wheel was flame cut from mild steel plate, $\frac{3}{4}$in in thickness, and the gapped edge flange which performs the locking of the train was bent from a strip of plate of slightly lighter gauge and welded to the side of the wheel. In the original wheel the flange was attached by riveting, and the new wheel, though almost identical in appearance with its predecessor, is of much stronger form. This advantage is a most important one, for the wheel, and particularly the flange, has to take the full shock of locking when the last blow of each hour has been sounded. The teeth of the new wheel were, of course, machine cut, but the tooth form was carefully chosen to be as similar as possible to that of the old wheel.



CONINGSBY "ONE HANDED" CLOCK TOWER

Most of the pinions showed considerable signs of wear, but this was also made good by welding and subsequent reshaping, and only in the case of the escape pinion was replacement unavoidable. Other points where welding was used to build up worn parts included the blade of the locking plate detent, the lifting surface of the warning detent and the tip of the hammer lifting lever. The correction of these details improved the security of locking, gave a better warning action and rendered the lifting of the striking hammer more positive and even.

The reconditioning of the wheel trains also included the replacement of all bushes, the repolishing of pivots, the overhaul of the winding ratchet mechanisms, and the refitting of the overrun ratchet of the striking train "fly" or air brake.

The escapement was in very good order, and after the new bushes had been fitted and wear in the connecting-rod made good, the pallets only required slight adjustment and repolishing. The pendulum-supporting bracket was refixed to the tower wall and the suspension spring was renewed, but there was no need for extensive replacements at any point. All iron parts throughout the clock were treated to remove rust, and all but the acting surfaces were afterwards painted with several coats of a hard anti-rust finish.

The condition of the wooden framework was so good that scraping, cleaning and the application of a wood preservative solution was all that was required. The joints were quite sound and there was no sign of any attack by worm or rot. The strange Y-shaped pivot blocks, in which the striking warning and locking detents pivot and are retained by wedges, were carefully preserved.

The timekeeping part of the clock is connected to the dial, which is considerably higher up the tower, by a length of shafting, provided with contrate wheels at each end, and pivoted in bearing blocks attached to the tower wall. The upper contrate wheel was damaged, and a new tooth had to be built up by welding and reshaping. The bearing blocks required new bushes, but were otherwise serviceable and were refixed. It was not possible to retain the spindle on which the hour-hand was mounted, for this had rusted through exposure, and a new spindle was accordingly made, care being taken to ensure that it was as nearly as possible a replica of the original.

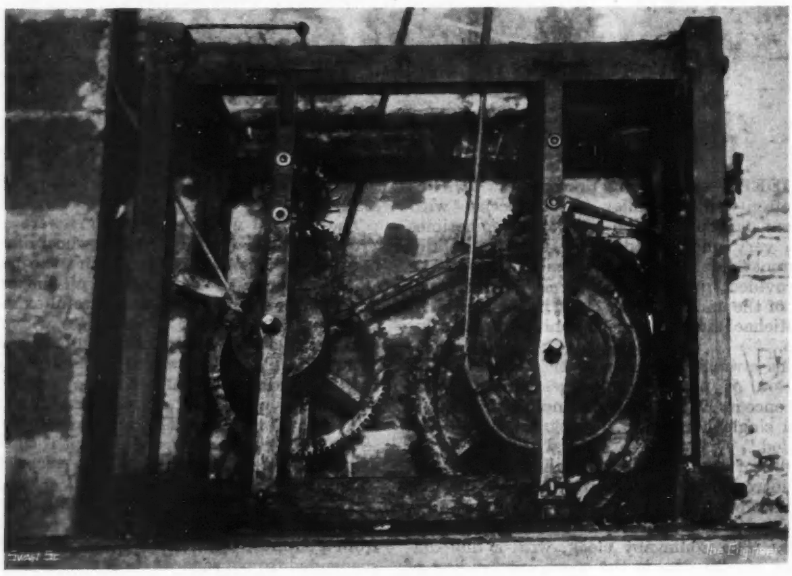
The hand itself is of sheet copper and is stiffened and reinforced by a wrought iron plate of D section fitted to the back. All this original work was retained, but a new flange to provide a sound attachment for the new spindle was fitted to the reinforcing plate and united to it by welding in order to avoid the use of bolts.

The dial, which was painted directly on the stonework of the tower wall, was in plain black and white, but when preparatory work for the repainting was in hand traces of original colours were discovered, and these have been faithfully followed in the restoration. The main background is white, with black Roman numerals, but the quarter and half-hour markings are in red, as is the disc in the centre. Around the circumference is a ring of blue and the hand is black with a gilt line running down the centre.

The striking hammer, which sounds the hours on the tenor bell of the ring in the belfry, was completely reconstructed by welding to form as nearly as possible a replica of the original. The connections between the mechanism and this hammer required complete renewal, but here again the original design was carefully followed.

Since the re-erection of the clock it has kept excellent time, and well repaid the care that was expended on it. A check against the time signals transmitted by the B.B.C. indicates that its time averages an error of a few seconds a week, which is an exceedingly good performance from such an old machine.

It may be worth mentioning in conclusion that the clock was a very familiar landmark to many of the air crews of Bomber Command during the war, for the church closely adjoins Coningsby aerodrome, which was one of the operational stations of the R.A.F.



CLOCK MECHANISM

SUMMER SCHOOL IN ELECTRON MICROSCOPY.—A Summer School in Electron Microscopy is to be held in the Cavendish Laboratory, Cambridge, from August 18th to 24th next. The School will provide a grounding in the theory and applications of the electron microscope, and it is intended for those who have some familiarity with the instrument and who are already, or in the near future will be, operating it in physical, chemical or biological laboratories. The lectures will deal with the fundamental theory and operating principles of the electron microscope, and the various techniques of specimen preparation will be demonstrated and practised in small groups by the class. The three leading models of instrument will be used, and discussions held on their special characteristics. A detailed syllabus and form of application for admission may be obtained from G. F. Hickson, M.A., Secretary of the Board of Extra-Mural Studies, Stuart House, Cambridge.

Gas Retort Bench Top Ironwork Reconstruction

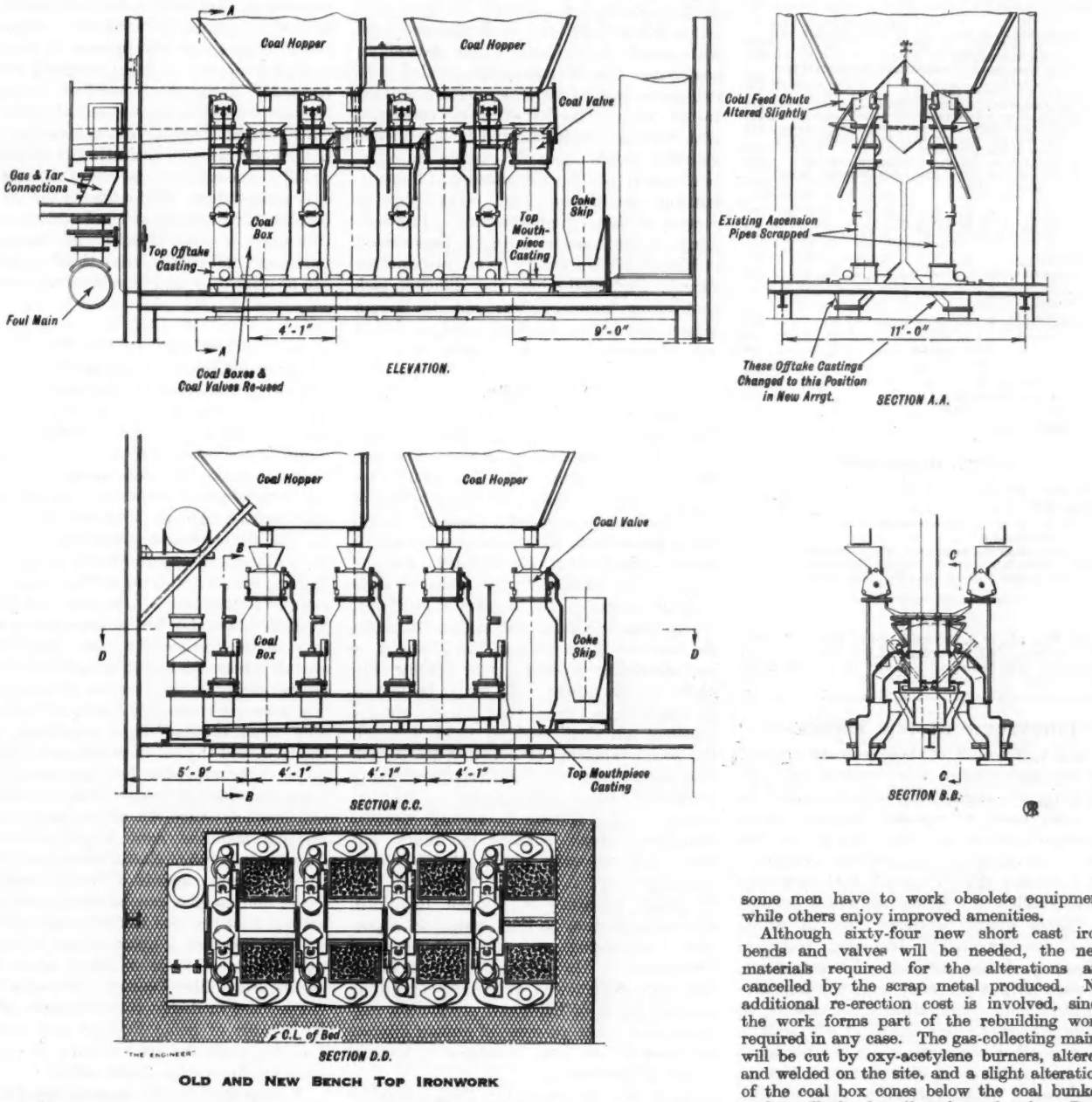
GAS undertakings to-day are only too anxious to modernise their plant, not only to obtain improved working results, but also to improve working conditions and reduce maintenance costs. On the other hand, shortage of materials may restrict repairs to essential work and they led to a request from the men that the equipment of the remaining settings should be similarly converted without any great delay. At first it was thought that further conversion could not be carried out until the remaining retort benches were rebuilt, say, in three or four years' time, but later it was decided that this year's repair programme should include the letting down of eight settings of 33in retorts, four settings to be reset and four partly rebuilt, no new top or bottom ironwork being renewed.

The old and familiar arrangement of 33in top ironwork is shown in the upper views reproduced herewith. Since the coal boxes, coal valves, searing castings and overhead collecting mains were all in fair condition, it was found that by placing the existing gas-collecting mains on the centre line of the buck-stays and changing all the bottom off-take castings over to their opposite positions in the setting, and also introducing new short off-take pipes to the collecting mains in the new positions, that an improved top ironwork could be obtained quite simply and immediately.

The company's new arrangement showing the collecting mains, liquor sprayed off-takes and coal boxes is shown in the lower accompanying views.

By this reconstruction the company expects that not only will the new working conditions be realised quickly, but also that there will be an improvement in gas-making results. Nevertheless, the main advantage that will accrue will be the elimination of dissatisfaction and complications which usually arise when some men have to work obsolete equipment while others enjoy improved amenities.

Although sixty-four new short cast iron bends and valves will be needed, the new materials required for the alterations are cancelled by the scrap metal produced. No additional re-erection cost is involved, since the work forms part of the rebuilding work required in any case. The gas-collecting mains will be cut by oxy-acetylene burners, altered and welded on the site, and a slight alteration of the coal box cones below the coal bunker outlet will also be effected on the site. It is felt that this development may not be without interest to undertakings with similar plant.



OLD AND NEW BENCH TOP IRONWORK

"A CENTURY OF PUBLIC HEALTH."—A pamphlet entitled "A Century of Public Health," is being circulated by the organisers of the Public Health and Municipal Engineering Congress and Exhibition, which are to be held at Olympia, London, from November 15th to 20th. It traces concisely the progress that has been made since the passing of the first Public Health Act in 1948, and emphasises that the knowledge, skill and resources of engineers and industrialists have contributed much to the improvement of public health and municipal engineering services during the last hundred years.

THE ENGINEER

MAY 14, 1948

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NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

For Subscription Rates, see page 2 of Advertisements.

DEATH

ON May 4th, at 3, Downside Road, Bristol, ALFRED W. BENNIS, M.I.Mech.E., A.I.E.E., M.Inst.Fuel, Chairman and Managing Director of Bennis Combustion Ltd.

INDUSTRY'S HUMAN PROBLEMS

MANY, if not all, of those who are engaged in the industries of this country, and particularly the engineering industry, must be growing weary of repeated exhortations to increase production. Since the end of the war these exhortations have been proclaimed at a steadily rising *crescendo* until now they have swollen to a *fortissimo*, which perhaps at times almost deafens those to whom they are directed! Increased technical efficiency, better methods of management, greater output per man-hour, the improvement of joint consultation arrangements, all form subjects for this chorus of exhortation. Nor, whether as a consequence of exhortation or, just as likely, in disregard of it, has the engineering industry failed to press on with such improvements. For instance, Mr. Strauss, Minister of Supply, was able to say last Monday at Birmingham that between January, 1946, and December, 1947, the rate of production in the major engineering industries expanded by almost a half with an increase of only 15 per cent in those employed, surely a great tribute to managements and their efficiency. It might well be added that but for shortages of raw materials and delays imposed by controls output to-day could be even higher than it is.

With such thoughts in the background we listened with considerable interest to the discussions at a conference on "Human Factors in Industry," which the British Association held at Leamington Spa last Saturday. It is not suggested for a moment that human factors present a problem which is new to industry, for it has long been realised that the success of improved mechanisation and production techniques necessarily depends to a large extent on their willing acceptance by the human element. But probably to-day, with the insistent demand for still greater production, industry is more conscious than ever before of the human problems with which it is faced. Last Saturday's conference was conveniently divided into two parts, each of which was closely related to the other. The first part was concerned with working conditions and included some valuable contributions by experts on industrial health, about such matters as lighting, heating, ventilation and other physical aspects of factory environment. Professor Lane, of the Industrial Health Department of Manchester University, in an introductory survey, suggested that the difficult task confronting industry was not to design bigger and better machines, but to find a way for man to live happily with the machine. He claimed that it was the responsibility of those who brought the man and the machine together to provide for that ideal, for without it, he contended, there was no purpose in industrial efficiency. But Professor Lane went on to admit that many of the researches undertaken by bodies like the Industrial Health Research Board might not seem to the practical man to have obvious application to industry, and he appealed to researchers to make a more realistic approach to industry's problems. Those responsible for the design of plant, the lay-out of works, and the planning of manufacturing processes, will readily subscribe to that appeal. It would be unwise to conclude, however, that having created excellent physical working conditions, all the social problems of industry are solved. The second part of the British Association's conference, which was devoted to the consideration of "Human Relations," stressed that fact. Much, perhaps too much, has been said recently about incentives in industry. Dr. A. T. M. Wilson, of the Tavistock Institute of Human Relations, directed attention to that matter in a new way by talking on "The Problem of Deterrents." He reached the conclusion that such evidence as we possess concerning existing levels of industrial production suggests that great reserves of human interest and energy are still untapped in current industrial practice.

It is well to remember that successful leadership is not industry's sole human requirement, for satisfactory "subordinateship"—as another speaker at the conference termed it—has an important contribution to make. A first-class physical environment, desirable as it is, cannot by itself ensure a fully contented band of workers, leaders and subordinates alike, who are enthusiastically devoted to the success of the undertaking in which they are employed. The highest pitch of enthusiasm and devotion obviously cannot be reached until employers and employed are wholly of one mind. But except for short periods like that which succeeded "Dunkirk" that unity cannot be expected to become complete. To ask that it should would, indeed, savour of "crying for the moon" at a time when there is much discussion and dispute in industry about restrictive practices and about profits, prices, wages, working hours and other matters, and when the Government's policies are themselves imposing controversial burdens of controls and regulations. Moreover, is such complete unity wholly desirable even if it could be attained? Is not a satisfied community likely also to be a stagnant one? It is the conflicts of individuals, of parties and of classes that add interest to our lives and make possible changes in our ideals and methods. Managements and men, employers and employees will never see all things in quite the same light. But essentially there is the unity between them that both prosper or fall by the success or failure of the industry or firm they serve. That is a unity that should constantly be emphasized and continually be cultivated, so that when the inevitable disputes and differences arise their discussion can be carried out in friendliness and without suspicion.

STABILITY IN FLIGHT

MANY engineers no longer in the first flush of youth will recollect that by the time of the first World War we had proudly learnt to build aircraft that were inherently stable in flight. So effective was this new knowledge that, as some may remember, a common criticism by pilots of the day was that many such craft tended to be too self-willed. It was not the obstinate dive which was feared, but the stiffness in horizontal flight which slowed fighting aerobatics. Hence it is a matter of surprise that a lack of adequate stability in flight should to-day be the suspected cause of some of the crashes of certain experimental aircraft under trial, and sometimes even of aircraft newly put into service. The explanation which is commonly given, and is probably true, is that flight conditions have changed, and that of these changes the chief factor is the rapid rise in flying speed. The higher the speed the greater will be the forces, and couples, which act on the aerodynamic surfaces and the more appreciably those surfaces will suffer elastic distortion. Once the distortion exceeds a certain limit the forces and couples can become so severe in amount that the nice balance which inherent stability requires is upset. That this is the explanation of some of these unfortunate events seems likely enough, but with meticulous care in design this possibility should be capable of being foreseen and avoided. For this work the general body of existing technical knowledge should suffice.

A more troublesome cause of instability is the change in the type of airflow as the Mach number approaches unity, or even, with some aerodynamic shapes, within 15 or 20 per cent of it. When the critical *régime* is reached the air forces change very swiftly. Moreover, their centres of pressure suddenly alter. Nothing could well be a surer means of upsetting stability and in some cases its suddenness may be catastrophic. To study this action is not easy. The apparently obvious remedy is to follow the wind tunnel technique of model testing, which, for many

years, has proved so useful in the design of new types. Unfortunately, this simple solution will not work. The wind tunnel has yet to be devised which can give the average designer intelligible data when the air speed lies within the sonic range, i.e., Mach numbers from 0·85 to 1·15. It is for this reason that experimental work on proposed new high-speed types is not infrequently carried out with pilotless prototypes whose flying is controlled from the ground by radio and the performance recorded by similar means. It might be thought that with the highly efficient parachutes of to-day a pilot-flown model could more easily be used, but experience shows how hard it is to make effective use of a parachute once catastrophic instability has set in.

Some may wonder whether flying at sonic, and even supersonic, speeds can have enough merit to justify the risks involved. But if the Air Forces call for such craft, and the public—wisely or not—seeks faster and yet faster air travel, the engineer, as universal provider of the world's needs, has no alternative but to do his best to meet the challenge to his skill. One of these new demands comes, as it happens, right at the other end of the speed scale. It might be thought that little difficulty about stability in slow hovering flight need be anticipated. For if the helicopter's windmill is driven faster the craft will rise, if slower it will fall, and nothing could well appear simpler. Experience, however, shows that the matter is not so simple after all. The trouble here does not arise because of any approach to sonic speed, though, of course, the high peripheral speed of the windmill has to be watched, but because of the change of airflow through the windmill disc. To rise, the air must be pushed down, but when descending autogiro fashion, with the engine off, the airflow is upwards through the disc. It is evident that an unstable condition is bound to arise while the flow is reversing, and it is not astonishing that there should often be an important and possibly serious loss of height when passing through this transition period, so that if the ground is near the vertical speed on landing may well easily pass the undercarriage crash limit. The original Cierva autogiro was, of course, always free from this trouble, as the airflow was invariably upward through the disc. Thus, to combine all the advantages of both these types of rotary-wing aircraft may prove difficult, though it is certainly a task well worth the attention it is now receiving. It is a striking situation that adventurous work on the stability factors should be called for simultaneously at both ends of the speed scale.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

INSTRUCTIONAL HANDBOOKS

SIR,—Mr. David Vine, in his article on "The Preparation of Instructional and Servicing Handbooks" (THE ENGINEER, March 19, 1948, page 274), gives much sound advice, but he also makes two dangerous statements.

"Just as the men would talk who are to use the book, so," he maintains, "the book should be written; even grammar could be sacrificed on the altar of simplicity."

If I had to chose between reading pretentious jargon and reading unpretentious colloquial English, I should choose the latter, because it is more honest and likely to be more accurate; but that preference does not mean that either is the best way of conveying instruction. Does the workman of to-day speak as logically and simply as his grandfather spoke? I know an old countrywoman whose "illiterate" speech is a delight and an education, because she thinks before she speaks and uses little words that say what she means. Nowadays, it is our silly habit to say something that means what we mean—and leave the listener to work it out for himself.

The duty of a writer is to address his reader in the most effective language. The most effective language is the one the reader understands, but this is not necessarily the one he speaks. In fulfilling that duty it is pedantry that should be sacrificed "on the altar of simplicity," not grammar; the kid gloves that should be thrown away, not the tools.

F. W. ROGERS.

London, W.1, May 4th.

Electricity Charges

AT a Press conference in London on Thursday, May 6th, Lord Citrine, chairman of the British Electricity Authority, made a statement explaining the necessity for adjustments in electricity charges to, mainly, non-industrial users in certain towns and districts. Lord Citrine pointed out that electricity was one of the few exceptions to the general rise in prices that had occurred during and since the war. Taking the country as a whole, non-industrial users paid a lower average price for their electricity in 1946–47 than in 1938–39—1·415d. per unit, compared with 1·598d. per unit. Since, in the interim, the price of coal to generating stations had more than doubled, and freightage, wages and other costs had also increased substantially, the continuance of electricity tariffs generally at pre-war levels required some explanation. The reason was that, in line with Government policy during those years, electricity tariffs were stabilised, although in many cases this involved the undertakings in losses, which necessitated using up reserves. Rising coal costs were to some extent automatically passed on to industrial consumers by the operation of a "coal price variation" clause in their supply contracts, whereby the electricity charges rose fractionally as the price of coal went up. On the other hand, such coal price variations were very rarely incorporated in domestic supply tariffs. Broadly, then, domestic supplies were given at increasingly uneconomic prices. Moreover, since the war ended, domestic consumption had shown a big increase, whereas the sales of industrial units had increased only slightly. The effect of these changes had been that during the last two years deficits had appeared in an increasing number of supply undertakings. So pronounced had this trend become that on vesting day, when the industry was nationalised, more than 150 undertakings were operating under conditions which, if allowed to continue, would have resulted in an aggregate deficit of nearly £7,000,000 in 1948–49. Lord Citrine explained that this problem was being tackled in two stages. In the first place the B.E.A. had decided that charges for electricity must be adjusted in particular towns and districts where deficits for 1948–49 had been forecast. The amounts of the adjustments would vary, depending on local circumstances; details would be announced very shortly by the Area Board chairmen concerned. The second stage involved the long-term operation, which was now in hand, of overhauling the finances of the industry as a whole. One matter calling for prompt attention was the high flat rate charges prevailing in some localities; Area Boards were to review all cases where the price exceeded 6d. a unit and hoped to be able to announce some reductions in the near future.

Technical Reports

Stress Distribution in Reinforced Flat Sheet, Cylindrical Shells and Cambered Box-Beams under Bending. By D. Williams, D.Sc., A.M.I.Mech.E., and M. Fine, B.A. Reports and Memoranda No. 2099: Aeronautical Research Council, Ministry of Supply, H.M. Stationery Office. Price 6s. 6d.—The problem of the diffusion of load among the stringers of a plane reinforced sheet, when the applied forces produce no resultant bending moment tending to bend the sheet in its own plane, has already been considered in a previous report. The present work deals with flat sheets bent in their own plane by transverse loads and with cylindrical and tapered shells under similar bending actions. The results are applicable to monocoque fuselages and skin-covered wings, where the camber is appreciable. It is shown that a cylindrical shell of circular cross-section uniformly reinforced with stringers behaves exactly in accordance with the ordinary engineering theory of bending and the stresses are unaffected by "shear-lag." It is also shown that by suitable variation of the stringer sizes or stringer spacing round the periphery of the section, shells having cross-sections other than circular may have stress distributions strictly in accordance with the ordinary engineering theory of beams. By combining such stringer variation with a suitable peripheral variation of the skin thickness it is possible not only to obtain stresses exactly in accordance with engineering theory but to ensure that the applied loads are efficiently resisted by the material at disposal. The problem of the cambered box-beam with heavy corner flanges and with the cambered faces reinforced with a large number of stringers is given special treatment and a working approximation readily applicable in practice is suggested. Working rules are given to indicate when the proportion of stringer to skin area is such as to justify the use of plain engineering theory.

Aluminium and Aluminium Alloys in the Food Industry. Food Investigation Special Report No. 50, Department of Scientific and Industrial Research. H.M. Stationery Office. Price 3s.—The importance of aluminium in the food industry has increased steadily over many years and it is now used extensively for plant, equipment, containers and wrapping materials. In planning further research with a view to extending the usefulness of the metal, the Low Temperature Research Station, D.S.I.R., has carried out a thorough survey of all the available information relating to the properties of aluminium and its alloys which might conceivably affect their corrodibility. This information, which was highly scattered and unco-ordinated, is given for the first time in this single comprehensive and critical report. The survey clearly shows that aluminium is inherently a very reactive metal and that its resistance to corrosion is entirely due to the presence of a highly protective film of oxide on the surface. The protective properties of this film have been considered both in relation to particular conditions at the surface of the metal and to those in the solution with which it may be in contact, for it is known that corrosion can be greatly influenced not only by the structure and composition of the metal at the surface, but also by the power of ionised substance in solution to penetrate, undermine or dissolve the film.

Literature

BOOKS RECEIVED

Diesel Operation and Maintenance. By Orville L. Adams. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 28s.

Steam Engine Builders of Norfolk. By Ronald H. Clark. Norwich: The Augustine Steward Press, Tombland, Norwich. Price 5s. 6d.

Theoretical Aerodynamics. By L. M. Milne-Thomson. London: Macmillan and Co., Ltd., St. Martin's Street, W.C.2. Price 40s.

Electric Power Stations, Vol. I. By T. H. Carr. Third edition. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 36s.

Mechanics. By John C. Slater and N. H. Frank. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 24s.

Computing Mechanisms and Linkages. By Antonin Svoboda. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 27s.

Garcke's Manual of Electrical Undertakings and Directory of Officials, 1947–48. London: Electrical Press, Ltd., 23, Great Queen Street, W.C.2. Price £3 3s.

Production Engineering. By E. H. Jones. Fifth edition. London: George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2. Price 17s. 6d.

The Iron and Steel Institute

No. I

Annual General Meeting

THE annual general meeting of the Iron and Steel Institute was held at the Royal Institution of Chartered Surveyors, Great George Street, Westminster, London, S.W.1, on Wednesday and Thursday, May 5th and 6th. During the business of the annual general meeting, and before the discussion of papers took place, Dr. C. H. Desch, F.R.S., the retiring President, was in the chair.

The President first referred to the death of Mr. Benjamin Talbot (Past-President and Bessemer Medallist) on December 16, 1947. He said Mr. Talbot was one of the best-known men in the steel industry and was instrumental in starting the basic open-hearth process in America. He had a long record of work at the Pencoyd Works, Pennsylvania, and developed the Talbot continuous process there. When he came back to England he gave the Institute an account of the process. He then joined the Cargo Fleet Iron Company, with which he was associated for a long time after that and also with the South Durham Iron and Steel Company. Mr. Talbot received the Bessemer Medal in 1908 and in 1928 became President of the Institute and also President of the National Federation of Iron and Steel Manufacturers.

The meeting stood in silence for a few moments.

The President then welcomed the members and visitors.

He added that their Norwegian friends had invited the Institute to visit Norway next year and, in all probability, those attending would leave England on June 25th and return on July 9th. The Norwegian steel industry, although not on so large a scale as in some other countries, had some particularly interesting features.

The Report and Accounts were adopted without discussion.

Presentation of Medals

The President then presented the Bessemer Medal for 1948 to Mr. W. J. Dawson, C.B.E., (formerly of Hadfields, Ltd.) in recognition of his contributions to the development of steel castings and to the production of alloy and heat-resisting steels. He said that Mr. Dawson had been associated all his life with Sheffield and was one of the early pupils of the late Professor Arnold. He obtained his Associateship in Metallurgy at what was then the Technical College of Sheffield—now the Sheffield University—and after a short time with Henry Bessemer and Co., Ltd., he joined the firm of Hadfields, with which he had been associated ever since. He had been in charge of the steel-making department of the Hecla Works, being closely associated with the late Sir Robert Hadfield, and was responsible for most of the experimental work on which the researches there were based. During the last war he was Chairman of the Technical Advisory Committee of the Special and Alloy Steels Committee (Steel Control) of the Ministry of Supply, a member of the Metallurgy Committee of the Advisory Council on Scientific Research and Technical Development, and a member of the Iron and Steel Technical Committee (Ministry of Supply). He was also Chairman of the Tanks Cast Armour Committee from its foundation and a member of the Tanks Wrought Armour and Aircraft Armour Committee, which contributed so much to the development of the equipment of the fighting forces. Mr. Dawson was now Hon. Vice-President of the Iron and Steel Institute.

Mr. Dawson expressed his appreciation of the award and thanked all those who had worked with him in research for the great help they had given him, especially during the war years, when metals were urgently wanted.

The President then presented the Sir Robert Hadfield Medal for 1948 to Mr. A. Preece (Leeds University), awarded in recognition of his researches on the overheating and burning of steel. He remarked that Mr. Preece was Lecturer and Reader in Metallurgy in Leeds University, that he had held industrial positions, and had been Research Assistant to Professor Edwards at Swansea. He was President of the Leeds Metallurgical Society and, as such, was Honorary Member of the Council of the Institute. He added that Mr. Preece had established quite a reputation for original work in quite a small University Department and it was a great pleasure to hand him the Medal.

Finally, the President presented the Willams Prize for 1947 to Mr. R. Fowler, of Messrs. Richard Thomas and Baldwins, Ltd., of Ebbw Vale, for his paper on "Blowing out a Blast-Furnace."

Mond Nickel Fellowships in Metallurgy, 1947

Awards were announced to Mr. D. R. G. Davies for the study of the application of statistical methods to plant metallurgical and management problems, with particular reference to the steel industry in England and the U.S.A., and to Mr. L. H. Walker for the study of the methods of application of group industrial research, particularly in relation to the fabrication of light metals in the U.S.A.

Induction of New President

The President then inducted his successor, Sir Andrew McCance, F.R.S., and in doing so said that in the steel industry there were many distinguished industrialists and, on the academic side, many distinguished research workers. The combination of a successful manager as head of a great firm and a distinguished scientific investigator was rare, but they had that combination in Sir Andrew McCance, who had made a great reputation in both fields. What was more remarkable was that Sir Andrew had been able, even in later years, to combine these two functions while carrying on the direction of a great business—sharing it with Sir John Craig—and had found it possible to carry out research work of a really abstruse character. There was certain work he had been doing lately which had not yet been published but which it was hoped would be published sometime, which would rank very high in the research records of the industry.

Sir Andrew McCance, F.R.S., then took the chair and proposed a vote of thanks to Dr. Desch for his services to the Institute during his term of office.

Mr. Peter Brown seconded. The vote of thanks was cordially given.

Sir Andrew McCance, F.R.S., then gave his Presidential Address, an extract from which appears below.

THE DEVELOPMENT OF THE OPEN-HEARTH FURNACE

Furnace Dimensions

It must be admitted that the design of melting furnaces is still entirely empirical and based on experience, and that even the practical rules used by furnace builders to determine the dimensions for a specified furnace capacity show considerable diversity when compared with one another. There is little room for variation in the determination of the cubic capacity of a bath to hold a given weight of steel, but thereafter the area of the bath is generally fixed by allotting anything from 2 square feet to 6 square feet of hearth area per ton of steel, or by the inverse process of first fixing the depth of the bath from previous experience of the behaviour of similar furnaces. In either case there is ample latitude for exercising individual judgment and few of us have not experienced the disappointment of building furnaces whose performances fell short of expectations.

The practical relation where there is least disagreement is the ratio of length to breadth of the bath and for most modern furnaces this lies between 2·8 and 3·0. It is controlled by the burning characteristics of the gas flame and limited by the desire not to have too long a travel of the charging machine ram and consequently not too broad a furnace chamber within which the ram and box have to work.

It is accepted that the depth of the bath is an important factor in determining the production rate, since heat is transmitted to the charge mainly through the upper surface by radiation from the furnace walls and flame.

With this in mind it is a simple matter to deduce a rational basis for dimensioning the hearth by purely dimensional reasoning. The principle could be called that of thermal similarity in which the time to reach a stated temperature at the lowest point of the hearth would be the same for all furnaces irrespective of their charged weight.

The charge can be compared to a flat slab of thickness d which is absorbing heat at a constant rate from its upper surface. The heat will flow in from the surface and will create a temperature distribution within the slab which will be constantly changing, but at any instant there can be mapped out the contour line for a given temperature T_1, such, for instance, as a temperature near the melting point of the material of the slab itself.

From the theory of heat conduction the temperature distribution for such a slab can be represented by $F(x/\sqrt{kt})$, where x is the distance from the surface, k is the diffusivity and t is the time, and if we are concerned only with the temperature at the under surface of the slab at time t_1, this will be the same for all slabs so long as $d/\sqrt{kt_1}$ is constant.

If the duration of a charge is to be independent of the size of the furnace, the rate at which heat is supplied to the furnace chamber must be proportional to the weight of the charge since the heat consumption per ton is constant. The time required to reach comparable states of temperature distribution must therefore bear a fixed proportion to the total duration of the charge or, what is more readily obvious, must result from the absorption of a fixed proportion of the total heat supplied. The condition of thermal similarity that $d/\sqrt{t_1}$ = constant requires in consequence that $d/\sqrt{W}$ = constant (where W is the charge weight), that is,

$$\text{Depth of bath} \propto \text{hearth area} \propto \sqrt{W}$$

and

$$\frac{\text{Hearth area}}{\text{Depth of bath}} = \text{constant}$$

While the argument has necessarily been simplified by assuming that the bath of an open-hearth furnace can be compared in its thermal behaviour to a parallel slab, it is interesting to find that by plotting the hearth area (distance between blocks × distance between walls) of a number of British, American and Continental furnaces against $\sqrt{W}$, it can be confirmed that this rule arrived at by purely dimensional reasoning is substantiated from experience with furnaces ranging from 40 to 350 tons capacity. The straight line through the points in Fig. 1 gives

$$\text{Hearth area} = 51\sqrt{W}$$

The average depth can be expressed by a similar relation, but once the hearth area has been found the value for the depth can be more conveniently determined from the volume equivalent of the capacity after finding the true area of the bath from the drawing.

Furnaces designed on this basis should give a production proportional to their capacity. The Open Hearth Committee in 1938 rated furnaces according to their hourly production rate per 100 tons of capacity, but this is merely equivalent to the number of casts per week. On a continuous week of 168 hours, if N charges are obtained, the hourly rate will be $NW/168$, and if this is expressed per 100 tons of capacity,

$$\text{Hourly rate per 100 tons capacity} = \frac{NW}{168} \Big/ \frac{W}{100}$$

$$= \frac{N}{1{\cdot}68}$$

An hourly rate of 10 tons is equivalent to seventeen casts per week—by no means an impossible

figure. There are 225-ton furnaces in America using oil firing and 52 per cent of hot metal giving this result, and a 90-ton gas-fired Venturi furnace with cold charging at Glengarnock has also reached this target when scrap was of better quality than it is unfortunately to-day.

But it must be admitted that with the large tilting furnaces which are necessary for working the high-phosphoric pig irons of Britain such a high rate is unattainable at the present time. Nevertheless the mere possession of a target figure has usually been in itself a sufficient incentive to technicians.

Assembly of Raw Materials

The problems of organisation in cold metal shops centre round the supply and handling of the pig iron and scrap and the correct timing and sequence of these operations.

A popular construction for such a shop in this country places the pig iron and scrap marshalling bay immediately behind and parallel to the open-hearth bay. The scrap, &c., is handled by magnets and is dropped into the charging boxes situated on a fixed bench in the marshalling bay and immediately in front of the furnaces. For minimum operating time the top level of the wagons in which the materials are delivered to the marshalling bay should be level with the tops of the charging boxes as they rest on the bench. This necessitates a lowering of the railway level, but it has the great advantage that the magnet lift is reduced to a minimum,

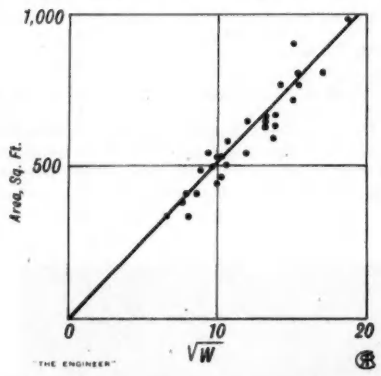


FIG. 1—*Relation Between Furnace Capacity and Hearth Area*

while, when over the charging box, it gives a minimum fall for the scrap into the box, which means not only a saving in operating time, but also a saving in wear and tear.

Magnet cranes for this service must be built more than usually strongly and have powerful motors. Their maximum rate of length or cross travel is not of such importance as their powers of acceleration, for the movements at work are restricted to short distances for speedy handling. There are few existing cranes in Colvilles, Ltd., which have not had their motors replaced with larger units since they were first installed in an endeavour to quicken the filling of boxes.

This in turn has created another problem, for with rapid starting and stopping the swinging of the magnet is greatly increased and control by the operator requires more skill if the time saved is not to be lost again waiting for the magnet to steady. Swinging is inevitable with a single rope, and after carrying out experiments with models, a four-rope magnet crane was designed which has proved successful in appreciably reducing magnet swinging during operation.*

With the lay-out described above each open hearth in a shop has allotted to it a length of charging box bench equal to the furnace spacing. At the commencement of charging this bench can be assumed full of filled boxes, and during the time taken to charge these boxes into the furnace the empty boxes should be refilled. With quick-acting furnaces and particularly with light-grade scrap this requirement places a definite limit on the size of the furnace for which such a lay-out is efficient. As furnaces get larger and scrap gets lighter a separation of the marshalling bay from the furnace bay becomes absolutely necessary, so that the larger number of scrap boxes required can be serviced by several cranes and the time of refilling curtailed.

A change in operational method follows in consequence, for if boxes on bogies are to be run into the furnace shop they can just as readily be placed immediately in front of the furnace and charged with a single cross movement of a floor charging machine and thus avoid the time taken by the slewing movement required by the overhead type of charger.

Quite an appreciable saving in time can be obtained in this way and a time study recently carried out on all the operations involved has shown that to charge one box and return it to its starting point requires less than half the time with a floor type than with the overhead type of machine. Since in future large furnaces will be an economic necessity, it is certain that separate marshalling bays should be embodied in all designs of new melting shops for quantity production.

Charging Time and Production Rate

After the furnace has been charged with cold materials the heat input is increased to its maximum and thereafter the melting of the charge proceeds according to the characteristics of the furnace and the skill of the operator. It is general experience that the length of time required to work the charge is dominated by the time taken to charge the furnace and in order to obtain information on this matter an average was taken of many charges in one shop grouped under their charging times. When the time from charge to tap was plotted against the charging time it was found that a reasonably straight line was obtained, as shown in Fig. 2.† This line is given by

$$\text{Time of charge} = 3{\cdot}0 \times 1{\cdot}45 \text{ (charging time)}$$

and it demonstrates that for each extra hour taken to charge the furnace the duration of the charge is prolonged by 1·45 hour. The furnace capacity was 88 tons in this case, so that the production rate per hour was $88/(3{\cdot}0+1{\cdot}45t_c)$, t_c being the charging time. With $t_c = 2{\cdot}0$ the production rate would be almost 15 tons per hour, and I do not think that this is an impossible figure for a furnace of this size. It is certainly about 40 per cent in advance of anything so far obtained, but with proper organisation of the raw materials assembly and adequate charging machines and boxes it is capable of attainment. In electric furnace operation, for instance, the advantages of quick charging have led to the development of basket charging, which has shortened the operating time appreciably.

The weight which a charging box will hold depends on its cubic capacity, and relating the charging time to the capability of the furnace to deal effectively with the weight of the cold materials involved necessarily implies also that the cubic capacity of the charging box bears some relation to these factors. The most important of these in this particular respect is the hearth area which controls the amount of heat received by the charge. The cubic capacity of the charging box should consequently vary with the hearth area and, like it, therefore, should be proportional to the square root of W, the charge weight. An approximate rule which seems to be adequate is

$$\text{Cubic capacity of box} = 3\sqrt{W}$$

While it is not suggested that such a relation should be an exact one, it may prove a useful guide in the formulation of a basis for design which is self-consistent.

It is interesting to record that the first charging machine designed by Wellman for a 40-ton furnace used a box 6ft by 24in by 18in with a capacity of 18 cubic feet—not very different from many of the boxes still used in Britain to-day. Admittedly, larger boxes require larger doors with larger arches, and large arches are the cause of endless trouble. But it is not easy to understand a certain reluctance in this country to adopt the water-cooled arch, which gets rid of this trouble and opens the way to a great many other operating advantages at a relatively slight increase in maintenance and supervision. Its use is certainly essential if larger charging boxes are to be used and the improvement in the output of greater capacity furnaces relatively cannot be achieved without them.

Boxes proportioned in this way will allow an adequate charging rate to be realised, a proper figure for which in future should not be less than 40 to 50 per cent of the capacity per hour. It may be thought that this figure is somewhat high and that no existing furnaces are able to take their charge so quickly. But to be given the equipment and machinery capable of such a performance encourages the desire to take advantage of it and few furnace operators could resist temptations of that kind if placed in their way.

Heat Input

There are two distinct stages in the course of a cold metal charge during which the transfer of heat to the charge is controlled by very different conditions.

In the charging and melting periods the furnace is in process of filling or is filled with cold mateal and the charge can absorb a large proportion of its heat requirements by direct radiation and conduction from the flame, since the opening of the doors and the cooling effect of the charge on the walls reduces their tempera-

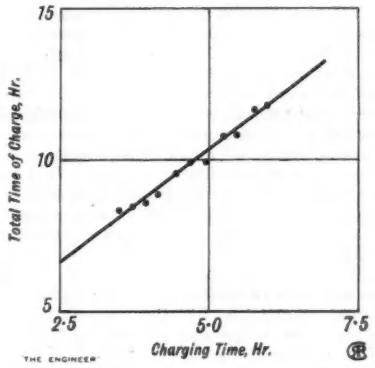


FIG. 2—*Variation of Charging Time with Total Time from Charge to Tap*

ture and consequently their contribution to the radiation energy of the furnace chamber.

Melting is therefore greatly facilitated by a hot intense flame directed down and through the charge. At this stage the efficiency of heat transmission depends on the degree of turbulence created in the burning gases. Since it is turbulence which controls the rate of combustion, what is desired is the maximum difference between the entering velocities of the gas and air so that the furnace end design should attain as near as practicable the ideal of a jet of gas projected into still air which entirely surrounds it. We have by no means reached the limit of possibility in this respect, the most successful attempt to achieve the best conditions being probably the Venturi design at the present time. In this type of furnace differences of 100ft to 150ft per second between the gas and air velocities are reached, but there are other furnaces in operation to-day where this vital factor has not been fully appreciated and which work with a velocity difference of only 30 to 40 per cent of this figure.

For intense combustion furnaces fired by compressed coke oven gas burners have marked possibilities in regard to future development in the industry.

When melting is complete and the charge is level new conditions arise where heat transfer by direct radiation from the flame is secondary to radiation from the hot walls of the furnace chamber.

The bath of liquid steel covered with slag is absorbing heat because of the chemical reactions and conduction through the hearth and so is at a lower temperature than the furnace walls and

* This crane was designed by Mr. T. W. Hand and constructed by Russell and Co. (Motherwell).

† I am indebted to Mr. J. Gibson, of Glengarnock, for these results, each point being the average of about twenty-five charges in each class.

roof. It is receiving more heat by radiation than it gives out and this difference is supplied by heat from the flame.

Expressed as a percentage of the total radiated energy, this difference can be stated with sufficient accuracy in terms of the absolute temperature T_1 of the walls and T_0 the temperature of the bath as

$$D=100\left(\frac{T_1}{T_0}\right)^4-1$$

The bath temperature is usually about 1600 deg. Cent. and this expression shows how rapidly D increases with the value of (T_1-T_0). The limit of the wall and roof temperature with silica bricks can be taken as 1650 deg. Cent., and in those circumstances the percentage of the total heat received by the bath which the flame must supply to maintain steady conditions is 11·1 per cent.

This is exactly in line with the experimental results given in that very valuable report on "The Influence of Port Design on Open-Hearth Furnace Flames,"‡ where the measured difference between the downward and upward radiation was approximately from 8 to 15 per cent.

If the use of basic bricks would enable the furnace walls and roofs to be run at 100 deg. Cent. higher in temperature, the rate of heat input into the bath from the flame could be raised to 36 per cent instead of 11 per cent, and this would obviously benefit the rate of working greatly. Such developments, it is well known, are already in active progress.

Chemical Reactions

Within the past twenty years great progress has been made in our understanding of the physical chemistry of steelmaking processes, and the work of investigators in this country and abroad has now enabled a tolerably clear picture to be formed of the nature of the chemical reactions which take place and of the limitations in our control of them. It is much too large a field to be reviewed even briefly, and I shall only touch on certain aspects in connection with present and future rates of steel production.

The refining of steel in the open-hearth furnace is fundamentally a slag-metal interaction, controlled by the composition and temperature of the two phases and the extent of their surface of contact. The *rôle* played by the furnace atmosphere, while not without importance, must be regarded as secondary to that played by the slag. During the finishing stage good steelmaking requires that slag composition must approximate to equilibrium conditions and this restricts within certain limits possible variations in slag composition.

It seems unlikely, therefore, that any great improvement in production rate can be expected from mere changes in slag composition. On the other hand, the dependence of reaction rates on diffusion across the slag-metal interface makes them sensitive to changes in the extent of that surface. The extreme rapidity of the chemical reactions in the Bessemer converter is very greatly assisted by the intense agitation and the large surface of contact thus created between the metal and the slag. But while this principle is clearly understood, it cannot be said that attempts to make use of it in open-hearth practice have met as yet with any success. It is a line of advance that still awaits the right inventor.

The effect of temperature is also important and it has been broadly said that chemical changes double their rate of reaction for every rise of 20 deg. Cent. in the temperature at which they take place. The provision of better refractories with a substantially higher softening temperature would enable furnace reactions to be speeded up appreciably, and in particular carbon removal which absorbs heat could be quickened by the greater heat flow into the bath from the furnace walls and roof.

The absorption of heat when carbon is oxidised by FeO is avoided when direct oxidation is carried out, and the prospect of doing this has been greatly strengthened by recent work on the use of oxygen in open-hearth furnaces, particularly in America. It has been shown there that oxygen can be used to increase the intensity of flame combustion by enrichment of the air, to melt scrap by jet impingement or to oxidise directly the carbon in the bath.

From the small part played by direct radiation it cannot readily be seen how the use of enriched air can contribute effectively to the heat balance or the production rate.

The melting of scrap by jet impingement will be more efficient, but undoubtedly the most extensive use for oxygen will be found in direct oxidation. In this case the reaction generates heat, which can be retained without punishing the furnace refractories, and it can be an aid in keeping the reaction temperature at a high level.

Of the technical difficulties so far encountered, the splashing of slag on the furnace walls and roof, due to the rapid evolution of carbon monoxide, when oxygen is blown into a high-carbon bath, gives rise to a pronounced increase in refractory consumption.

But the oxygen is a great help in shortening the time required to reduce the carbon to low percentages, i.e., 0·04 to 0·08, although its efficiency as an oxidising agent falls off rapidly at these lower contents. Low carbon in the bath requires a high-oxide slag and with lowering carbon the FeO in the slag increases and moves towards its equilibrium concentration. But this can only take place if the FeO required by the slag is supplied by the direct combination of the iron and the oxygen. So the lower the carbon the greater the proportion of oxygen used for this purpose and the greater the loss in oxidation efficiency from the steelmaking angle.

Such problems, however, need cause no disquiet. The use of oxygen is as yet in its infancy and there can be no question that its influence on future steelmaking practice will be profound. Already in America five casts per twenty-four hours have been attained from a 150-ton furnace with heat consumptions of 2·5 million B.Th.U. per ton, and although these are exceptional results, not always capable of repetition, they point the way to new standards of production.

The use of oxygen holds out prospects for the rapid production of steel which we can apprehend, but which at the present time we are wholly unable to assess. It will demand an expansion in the means to produce oxygen which we must regard as the initial steps taken towards the creation of an entirely new technical industry.

(To be continued)

‡ The Iron and Steel Institute, 1946, Special Report No. 37.

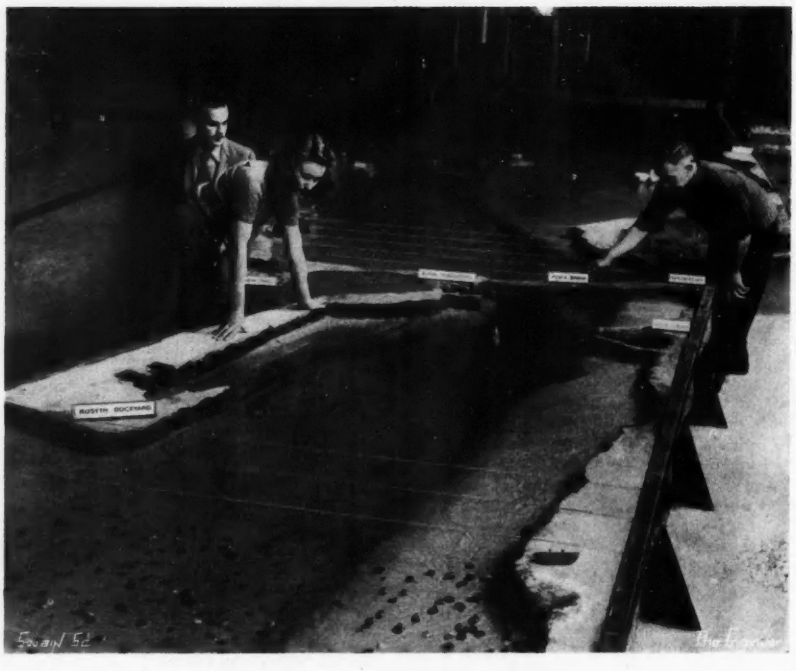
Tidal Model of the Firth of Forth

THE deposition of silt in the Firth of Forth in the region of Rosyth Dockyard has for many years been a major problem, and a considerable amount of money has been spent on dredging work to maintain the required depth of water. In order to investigate the causes and determine a means whereby this continuous deposition of silt can be avoided extensive research is being conducted by the Hydraulics Research Organisation of the Department of Scientific and Industrial Research at the National Physical Laboratory. This work was started by the Engineering Division of the N.P.L. some twelve months ago, prior to the hydraulic section being taken over by the D.S.I.R.

For these investigations a large tidal model of the Firth of Forth was built at Teddington. This model, which we illustrate above, is some 80ft long and is on a scale of 1 in 1800 horizontally and 1 in 144 vertically. In it there are reproduced all the main contours in the Firth of Forth between the regions of Edinburgh and Stirling.

It will be appreciated that with such a large model it would not be a particularly easy matter to reproduce exactly all tidal effects over the full length of waterway. Therefore, as only conditions in the region of Rosyth Dockyard are being investigated, attention has been concentrated on reproducing the tidal movements between the Firth of Forth Bridge and Charlestown to a high degree of accuracy. It is in this section of the model that a close study is now being made of tide-velocity relationship and reactions likely to impart conditions favourable to the deposition of silt.

In order to promote a flow of water at velocities corresponding to the time-tide move-



TIDAL MODEL OF THE FIRTH OF FORTH

ments, a plunger in the shape of a large box-float is reciprocated to displace the water in an open-sided tank, which forms the seaward end of the model. This plunger can be seen in its raised position in the background of our illustration. It is forced down to displace the water in the tank by a hydraulic jack, and its speed of return is controlled. The volume of water displaced by the plunger's downward movement and its speed as it flows up the waterways of the model are proportionate to those of the actual tidal flows in the Firth of Forth. An electrically operated servo device, which actuates the hydraulic jack mechanism, is controlled by means of a cam. The contour of this cam is laid out to reproduce plunger movements corresponding to a 12·4 hour tidal flow cycle every five minutes. A selector incorporated in the servo mechanism is designed to reproduce the effects of spring tide flows at appropriate time intervals in the model. To reproduce the effects of the various rivers which flow into the Firth of Forth water is fed continuously and at proportionate rates into the model through supply pipes situated at the appropriate points.

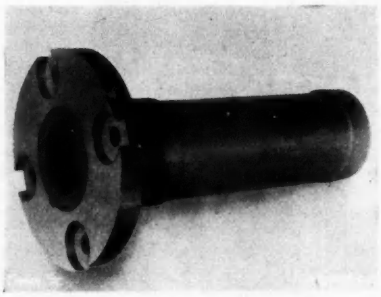
A bridge extending the full width of the model is movable on rails along its full length. From this bridge measuring and recording instruments can be suspended at any required point, to give comprehensive data on water flow, velocity, &c.

It is proposed at later stages in the investigations to experiment with training walls, pitched islands, &c., in the model, to change water flows, velocities, &c., in order to ascertain means of promoting conditions likely to be adverse to silting in the dockyard area.

Some Applications of Laminated Plastics

IN the course of a recent visit to the works of Tufnol, Ltd., at Perry Barr, Birmingham, we were shown a selection of the many applications for which the various grades of laminated plastics made by this firm have been adopted. Machined components produced vary from sieves for the textile industry to thrust washers, cam heels, commutator cores, bearings, bushes, &c., for motor-cars; from instrument and radio parts to drop hammer trip bars; and from deep-well submersible pump bearings to the bearings used on the paddle agitators of cement slurry and asbestos fibre mixers.

Many types of bearings have been made from laminated plastic materials which have proved very efficient in services where only water lubrication is possible or where mild forms of acid are present in the liquid being handled. In this connection it is interesting to note that stern-tube bearings machined in " Tufnol " are



STERN TUBE BEARING

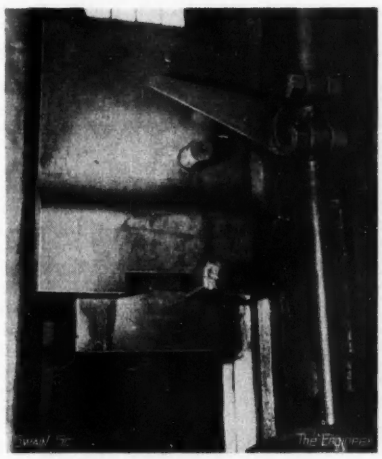
now giving good results on vessels. One such bearing, which we illustrate, was fitted to a 50 h.p. canal barge tug, and when last inspected, after three years' continuous service, showed no appreciable signs of wear. As this type of tugboat works for long periods in shallow waters containing a large percentage of grit and other abrasive materials, it provides a severe test for the abrasion-resisting properties of any stern-tube material.

Few bearings work under more arduous conditions than those fitted to agricultural implements, where they receive little or no attention and are continuously in contact with abrasive dust or mud. Hard wood bearings, often used on such implements, require frequent renewal, but now it has been found that laminated plastic bearings can be used with considerable success. The " Tufnol " bearing we illustrate was fitted to the shaft mechanism of a fertiliser distributor, and it is stated to have already outlasted the normal life of three wooden bearings with but little sign of wear. In addition to its ability to work with little or no lubrication, the laminated plastic bearing, when used in this type of plant, has the added advantage that it absorbs very little water, resulting in minimum expansion to cause binding on the shaft when under wet working conditions.

Bearing liners for rolling mills have been made by the company for several years and are now manufactured for journals ranging up to 25¼in diameter. A typical installation of this type of

BEARING FITTED TO FERTILISER DISTRIBUTOR

bearing block is in a mill which exerts a pressure of 1500 lb per square inch of bearing surface, with a rolling cycle of 36 seconds. For a third of the rolling period the water lubricated



LAMINATED PLASTIC TRIP BAR

bearing blocks take the full pressure exerted by the rolls.

The swells on textile looms are commonly fitted with leather linings, which wear fairly rapidly and have to be replaced about every six months. In an attempt to extend the life of such linings the leather was replaced by strips of " Tufnol " on a 45in loom. Swells lined with the new material were kept in continuous service for nearly three years, during which time some 105 million picks were woven. When the swell was removed for inspection it was found that there had been no appreciable wear on the lining and the swell was returned to service. It is expected that the lining will serve for at least a similar period before requiring renewal.

It is of interest to note that in recent years a process has been developed for the moulding of certain types of fabric-reinforced gear wheels in their finished state, having the reinforcing material unbroken and following the contour of the teeth. This new type of gear wheel, when made in large numbers, is considerably cheaper to produce than cut gears, although initial tooling costs are naturally somewhat higher.

An interesting case where " Tufnol " used as a substitute for a material in short supply has proved even more satisfactory in service than the original material occurred recently at the works of Thomas Smith and Sons of Saltley Ltd. At this firm's works considerable delay and loss of production was being caused, due to insufficient supplies of lignum vitæ used for the 11in long trip bars on electrically operated Chambersburg drop stamp hammers. Material used for these trip bars must of necessity have good tensile strength in addition to sufficient resilience to counteract the effect of striking the metal lever on the pole up to 8000 or 9000 times a day. As a substitute for lignum vitæ a " Tufnol " tube, 3in diameter, with a 1in bore was fitted to a hammer. After having been in use five months for eighteen hours each working day it is stated that the tube has not only outlasted the normal life of the lignum vitæ, but is still giving efficient service.

The high degree of machinability of laminated plastics materials is one of the main reasons why industry is able to take advantage of their properties to an ever-increasing extent. In the machine shops of Tufnol, Ltd., standard types of metal and wood working machines with slightly modified tooling are engaged in practically every class of machining in this material. Reasonably fine limits are being maintained with ease, and, with the correct tool forms, production work on such machines as capstans and autos is no more difficult than when working in the common metals.

Diesel-Electric Shunting Locomotives for the Irish Railways

WE have received particulars of the first of five new 0–6–0 diesel-electric locomotives built at Inchicore Works, Dublin, for the Coras Iompair Eireann. This locomotive, a photograph of which we reproduce below, has been designed for shunting and transfer work and is the first of its type to be introduced on the Irish railways. It was developed and built by the C.I.E. in close co-operation with Associated Locomotive Equipment, Ltd., of London.

The new locomotive has been placed in service on the 6 miles long route between the Kingsbridge goods yards at Dublin, and the North Wall yards, where the greater part of the rail-sea traffic of Eire is handled. This route includes a 1½ miles long gradient of 1 in 84.

With a weight of just under 53 tons in full working order and a starting tractive effort of 24,000 lb, the locomotive can handle trailing loads of thirty-five wagons totalling 400 tons gross. When used in transfer work the engine is capable of developing speeds of up to 25 miles an hour, and fifty wagons of some 600 tons gross can be hauled at lower speeds.

The power equipment consists of a six-cylinder, four-stroke Mirrlees " TLD T6 " exhaust-gas, pressure-charged oil engine, dedeloping 535 b.h.p. on the one-hour and 487 b.h.p. on continuous rating at 710 r.p.m. This engine is directly coupled to a 290-kW traction type main generator supplied by the Brush Manufacturing Company, Ltd. An auxiliary generator, which is mounted on the main generator, is driven through vee ropes and gives an output of 10kW on 90V, maintained substantially constant at all engine speeds by

carbon pile regulation. The engine and generator are mounted on a common bed-plate, which is suspended at three points on two main cross-stays in the frame. The doors of the generator compartment are fitted with filters to ensure clean air for the engine intake and for cooling the self-ventilated main and auxiliary generators.

The main generator supplies current to two nose-suspended motors coupled through double-reduction spur gearing to the outer axles. These traction motors are force ventilated by

SHUNTING LOCOMOTIVE FOR IRISH RAILWAYS

air from a blower in the generator compartment, which supplies 2000 cubic feet of filtered air per minute. Side coupling rods drive the intermediate pair of wheels and a gear demeshing arrangement is fitted to permit safe hauling of the locomotive at speeds of over 25 m.p.h.

A supply of 1100 gallons of fuel oil—sufficient for two weeks' running—is carried in main and auxiliary tanks between the generator compartment and the driver's cab. An electrically driven transfer pump delivers about 26 gallons of oil per hour from the main to the service tank.

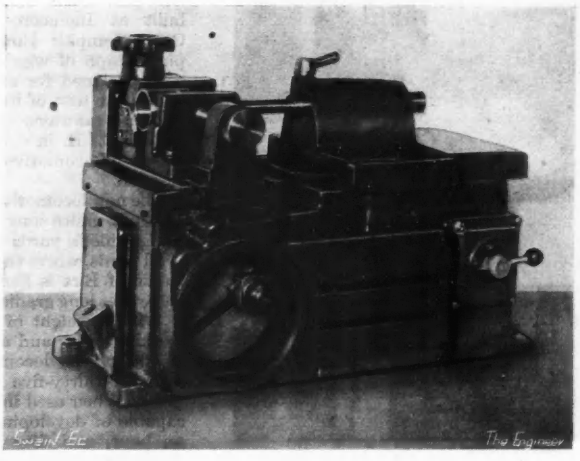
A bulkhead situated between engine and generator compartments prevents oil vapour getting to the electrical equipment. If it is required at a later date sufficient room is available at the side of the generator to install a motor-driven exhauster which will permit the locomotive to handle vacuum fitted stock.

Special attention has been given to the cab lay-out to ensure ease of operation and maintenance. A compact control cubicle houses all the electrical equipment for operating the locomotive, and the controls are duplicated to permit driving from either side of the cab. The series, parallel and starting contactors and the main motor reverser are all electro-pneumatically operated with air obtained from the brake system. Master controllers of the drum and finger type are designed to give four fixed engine speeds, 710, 580, 440 and 300 r.p.m.—the latter being also the idling speed—according to the power required. The governor settings giving these speeds are obtained by oil-electric units controlling the loading of the governor springs.

Bush Oil-Groove Cutting Machine

A MACHINE designed for quickly and easily cutting straight oil grooves in bushes has been introduced by Mastercut Machine Tools, Ltd., 18, Maddox Street, London, W.1. The machine is designed for bench mounting and cuts grooves up to 4in long in bushes with bores up to 3¾in diameter.

As can be seen from the photograph we reproduce below, the machine consists of a rigid base, at one end of which is a cross ways carrying the worktable, and at the other longitudinal ways along which the grooving tool slide reciprocates. The vice for holding the bushes has a fixed vee-shaped rear jaw and a plain moving jaw. Thus, irrespective of their diameter, bushes are automatically centralised in the rear jaw of the vice. All oil grooves are cut parallel to the centre line of the vee jaw. A locating plate set at the outer end of the vee takes the thrust of the grooving tool. The worktable is movable along its ways, to feed the bush relatively to the grooving tool,



OIL GROOVE CUTTING MACHINE

through the medium of a handwheel-operated lead screw.

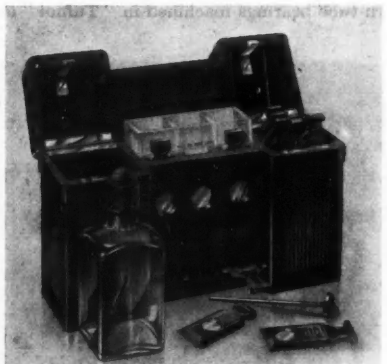
The reciprocating grooving tool slide is driven by a ½ h.p. motor enclosed within the base, the motion being transmitted through the medium of links and levers from a rotating plate on the motor shaft. The length of the cutting stroke is quickly and easily set by altering the position of the lever driving pin along a graduated tee-slot in the driving plate. At the end of each cutting stroke a stepped cam automatically moves the worktable slide a short distance rearwards to relieve the grooving tool during withdrawal movement.

Water-Testing Instruments for Chemical Treatment

To provide those responsible for water-treatment plants with a simple, rapid and accurate means of testing, so that adjustment can be made in chemical treatment according to variations in water, the Paterson Engineering Company, Ltd., Windsor House, Kingsway, London, W.C.2, has developed two instruments—the "Chloroscope" and the "Aquascope." With these instruments it is stated that tests can be rapidly and accurately carried out by any person of average intelligence, without any previous chemical knowledge.

The "Chloroscope" is an instrument designed for use by those in charge of chlorine treatment apparatus, and it enables the rapid and accurate determination of free chlorine to be made by a colorimetric method. In this method permanent non-fading colour standards are compared with a sample of water under examination to which there has first been added a measured quantity of a reagent supplied with the apparatus. This reagent produces a colour proportionate to the amount of chlorine present in the water.

The instrument can be seen in the photograph we reproduce. It comprises a plastic moulding with three main compartments. The central compartment contains a three-cell sampling unit of transparent "Perspex" with clear sides and bottom, but with an opalescent back. Three windows corresponding to the cells of the sampling unit are cut in the front



CHLOROSCOPE

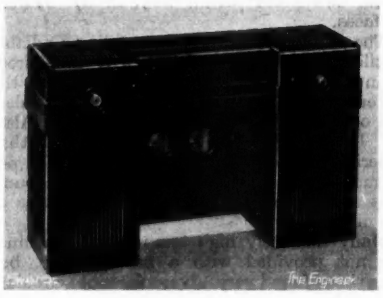
of the compartment. One of the end compartments accommodates a series of coloured slides and the other the bottle of reagent liquid. The slides are designed to fit in dovetailed slots in the sides and bottom of the central compartment and register over the observation windows. Liquid in the sampling unit can be viewed horizontally through 22mm. of solution and vertically through a depth of 66mm., giving three times the normal sensitivity. A black line engraved round the sampling unit indicates the filling level. The colour standards in the slides are circular tinted discs, and on each slide the colour value is indicated in parts per million of chlorine.

The method of using the "Chloroscope" is to fill the three compartments of the cell unit with the water to be tested, taking care that the centre cell is filled only to a white mark. To the sample in this centre cell is added a measured amount of testing solution. The testing solution having been mixed thoroughly into the sample, the cell unit is replaced in the box. If free chlorine is present a yellow colour will be produced in the centre cell.

In the slots opposite the two end compart-

ments of the cell unit, i.e., those cells containing water only, are placed other colour slides, and note is made as to which of these slides is nearest in colour to the chlorinated sample containing testing solution. The number on the top of this slide indicates the amount of free chlorine in parts per million. It may be found that by placing, say, the "0·2 p.p.m." slide in front of one end cell and "0·4 p.p.m." in front of the other end, that the colour developed in the test sample is between the two and a reading can be obtained with considerable accuracy between the two consecutive values. By using samples containing no testing solution for comparison allowance is made for any natural colour or turbidity present in the water.

The vertical viewing attachment is fitted on the underside of the central compartment with a device for holding three chlorine colour slides in a horizontal position. Beneath the slide holder is a white reflecting plate capable of angular adjustment. The three vertical viewing slides have values of 0·05, 0·15 and 0·25 parts of chlorine per million respectively, and the colour discs are so mounted that the apertures



AQUASCOPE

in the slides only correspond with the apertures in the box when used in the vertical viewing position. Conversely, the slides for horizontal viewing cannot be used for vertical viewing.

The three-cell unit is filled with water to be tested and test solution is added in the normal manner. In order to obtain vertical viewing readings the lid of the box is opened and the spring catch holding the reflector in the base is released. The reflector is adjusted to a convenient position to obtain a suitable angle for viewing the colour in the cell unit vertically through the depth of the water. By inserting one of the three vertical viewing standard slides at either end of the slide holder the readings of chlorine can be obtained.

Recent practice has restored the use of superchlorination of waters as an aid to effective purification. To control this treatment effectively it is useful to differentiate between the combined chlorine (chloramine) residual and the free uncombined chlorine residual; with simple modification the "Chloroscope" can be used for these separate determinations.

During recent years the measurement of the hydrogen ion concentration as a means of control of active as distinct from total acidity and alkalinity (pH) has come into extensive use in various fields of research and industry. To provide an easy and accurate method for the determinaiton of active acidity or alkalinity the "Aquascope" has been produced.

A convenient method of pH determination is based on the fact that certain reagents or indicators change in colour when acted upon by acid and alkaline solutions, the extent of the colour change having relation to the degree of acidity or alkalinity. By using certain dyes, a degree of colouration can be obtained which is a quantitative measure of the amount of active alkalinity or acidity.

The standard indicator—Brom Thymol Blue—supplied with the "Aquascope" has a range from pH 6·0 to 7·6 in steps of 0·2. The range of standard colours obtained by the use of this indicator are represented by nine permanent colour standards mounted in moulded slides, the pH value being engraved on the top of each slide. The instrument is similar in appearance to the "Chloroscope," but is arranged for horizontal viewing only. It consists of a plastic moulding having the necessary compartments and observation windows for horizontal viewing.

The standard pH range of 6·0 to 7·6 is sufficient for most natural waters, since pH 6·0 is slightly acid, pH 7·1 is neutral, while pH 7·6 indicates faint alkalinity. If in the course of a test it is found that the pH indication of a sample of water is 6·0 or 7·6, further tests are made with other indicators, in order to determine how much below 6·0 or above 7·6 the actual pH value is, since these are the limits of the range of the indicator solution in the set. Indicators and standard colour slides for pH values below 6·0 or above 7·6 can be supplied for use with the instrument.

Human Factors in Industry

A CONFERENCE on the subject of "Human Factors in Industry," organised by the Social and International Relations of Science Division of the British Association, was held at Leamington Spa on Saturday, May 8th. There was a large attendance and an official welcome was given to the conference by the Mayor of Leamington.

The afternoon session, at which Sir Henry Tizard, President of the British Association, was in the chair, was devoted to a discussion on "Working Conditions." An introductory survey was given by Professor R. E. Lane, Professor of Industrial Health at Manchester University, who said that a difficult task facing industry was not to design bigger and better machines, but to find a way for man to live happily with the machine and, at the same time, maintain his individuality. He went on to speak of the part that medical science could take in assisting industry, and emphasised that occupational health was obviously the concern of a team. That team, he suggested, must comprise not only the medical scientist, but also the engineer, chemist, personnel officer, caterer and foreman, whilst balancing and leading them all, there must be the industrial manager.

Professor Lane's next point related to the contribution which the doctor could make in solving the human problems in industry. In the first place, he said, an educative influence might be exerted. There was a vast amount of information available on human industrial problems which was not used, but the failure of industry and municipal undertakings to make use of that information appeared to be caused by ignorance rather than wilful neglect. It had to be admitted, Professor Lane continued, that many of the researches undertaken by bodies, such as the Industrial Health Research Board, may not have appeared to the practical man to have obvious application to industry. He thought that research bodies should bear that in mind and should adopt a very realistic approach to the problems confronting industry. Researchers, Professor Lane claimed, should be concerned not only with producing results, but with interpreting them for use in the field, and industry should be putting its problems before the research bodies rather than leaving it to the research bodies to find their own problems. There was also a need, Professor Lane urged, for many research workers to leave their ivory towers and mix in the hurly-burly of industry where they would see some of their problems in a different light, and where the need for much research of an operational character would immediately become apparent to them. Finally, Professor Lane emphasised the desirability of closer collaboration between medical scientists and engineers in the design of plant. Hitherto, he felt, there had been far too little co-operation, and if full use was to be made of our ageing labour force, this was a matter which should receive immediate attention.

The other principal speakers during the afternoon session were Dr. C. L. Cope, Director of Research into Human Problems, National Coal Board, who dealt with working conditions in British coal mines, and outlined various improvements which were being made; Dr. H. C. Weston, of the Industrial Health Research Board, who discussed the importance of efficient lighting in industrial establishments; and Dr. T. Bedford, also of the Industrial Health Research Board, who emphasised the need for satisfactory heating and ventilation in all places of work.

The subject of the evening session of the conference was "Human Relations." Sir George Schuster, chairman of the Industrial Productivity Committee's Panel on Human Relations, presided, and in his opening remarks suggested that a proper approach to the subject should keep in mind the desirability of making employment in industry the basis for a satisfactory life. An introductory survey was presented by Dr. T. G. Tredgold, of the Roffey Park Rehabilitation Centre, who put forward the view that far too little was known about the fundamentals of human relations in industry. He said that even where the essentials of leadership were being studied and taught, the study of "subordinateship" and fellowship was less advanced. It seemed to him that some improvement of human relations could result from an explanation of their basis on a very much wider scale than obtained at present.

Mr. D. Chapman, of the School of Social Sciences and Administration, Liverpool University, then spoke on "Incentives." He said that incentive schemes were often associated with attempts to improve production by replanning processes, by new methods and by increased division of labour, all of which were regarded as attempts to reduce the power of organised craft groups and to increase the proportion of unskilled and semi-skilled workers to craftsmen. At the present time, Mr. Chapman asserted, although many of the features of the pre-war situation were absent, large numbers of operatives were by no means convinced that full employment was anything but temporary, and they were therefore unwilling to consider changes in the organisation of their work which might weaken their position if unemployment returned. Mr. Chapman also added that to tackle production problems by exhortation on a national scale had little or no effect, and might even have a bad effect.

Following the talk on incentives, Mr. A. T. M. Wilson, of the Tavistock Institute of Human Relations, spoke on "The Problem of Deterrents." He began by saying that such evidence as we possessed concerning existing levels of industrial production, both here and in other countries, suggested that great reserves of human interest and energy were untapped in current industrial practice. The failures of joint consultation—and they were many—made it clear that the organisation and climate of industry were based on quite inadequate postulates about the needs and motives and potentialities of human beings. Difficulties over joint consultation were, Mr. Wilson stated, a serious factor in industrial morale. He went on to speak of the different industrial sub-groups—skilled and unskilled workers, weekly paid and salaried workers, union and non-union workers—between which tensions could be seen to exist in industrial life. An important first step towards removing conditions acting as barriers to co-operation in industry must be to look at any problems within an adequate frame of reference.

In conclusion, Mr. Wilson said that autocratic practice, and the expectation of it, were so deeply entrenched in industry that any attempt to change towards a more co-operative state of affairs was likely to be met with very considerable scepticism, which, if accepted and understood, could do no harm. But the first actions towards obtaining and practising co-operation within a factory were likely to be regarded by all concerned as a test case. They would therefore tend to have a significance out of all proportion to their real place in the scheme of things, and even a corresponding care in selecting a "safe" area in which to make a start would not evade that testing out process which, indeed, was constantly in action in all leadership situations.

Some Problems Encountered in the Lubrication of Steam Turbines*

By R. LOWE, B.Sc. (Eng.)

In discussing some of the problems encountered in lubricating steam turbines I would like to be regarded as speaking from the point of view of the practical turbine engineer, rather than that of the designer, and certainly not as an oil expert.

Although during the past twenty-five years or so the problems of oil sludging and attack of metal parts have occupied the attention of oil technologists, it is really comparatively recently—in fact, practically only during the past ten years—that the advance in the use of steam at high temperatures and pressures has given rise to problems engaging the very serious attention of the designer and making demands on the oil technologist to produce a product capable of standing up to increasingly exacting conditions.

Previous to this period of development a charge of almost any standard high-grade oil would give seven, eight or even ten years of service without trouble and without more attention than topping up to make up for unavoidable losses. An occasional analysis would show that the oil was maintaining its properties fairly adequately, until after a period the acid value would rise and sludging set in. The oil was then drained and a new charge put into the machine without any particular precautions regarding cleaning being adopted. Also the majority of turbines were not of very large capacity and a new charge of oil was not a very costly item.

To-day, however, conditions have changed, and the increase in unit sizes and rises in steam pressures and temperatures have made the conditions under which the oil must operate so much more onerous, that in many cases ordinary unprocessed turbine oils will not give reliable service for any satisfactory length of time. Because of this, before dealing with the subject matter proper of this paper, I would like first of all to discuss briefly the duties required of the lubricant in the system of a steam turbine.

The lubricating oil must provide a film which will effectively prevent metal-to-metal contact between running surfaces. These surfaces in a modern turbine will have rubbing speeds varying from practically zero, as in the case of pilot valves in a relay system, to 7000ft per minute for the journals, while bearing pressures will vary from a modest 40 lb per square inch to a possible 1000 lb per square inch at the contact surfaces of the gears driving the main oil pump and governor.

A second important duty of the oil is that it shall provide adequate cooling of the surfaces of the journals. The heat which must be dissipated is not only that due to the friction of the bearing surfaces and internal friction in the oil itself, but also the amount which is conducted along the shaft from the steam spaces and radiated into the lubricating system from adjacent steam pipes and casings. This latter amount can, of course, be considerably reduced by careful arrangement of the oil pipes, but the conduction of heat along the shaft cannot be avoided. In a machine of 30,000kW capacity operating with steam at about 800 deg. Fah., the quantity of heat removed by the oil flowing through the bearing at the high-pressure end may be as high as one million B.Th.U. per hour and the total quantity of heat removed from all bearings and thrusts may be in the order of four million B.Th.U. per hour.

A further requirement of the lubricant is that it shall provide the hydraulic pressure necessary to operate the governor relays and valves.

To give an availability of 90 per cent a turbine is required to operate almost continuously for some 8000 hours per annum, so it is evident that the service required from a lubricating oil in a steam turbine is very arduous, and the properties required are to some extent self-contradictory in normal oils.

The physical properties necessary in a turbine lubricating oil are :

(1) Low and flat viscosity temperature curve to minimise pumping power and give rapid response in hydraulic relay systems.

(2) High film strength to provide effective lubrication of gear drives, and also to avoid squeezing out from journal surfaces during shut-down periods.

As a general rule, of course, low viscosity and high film strength are not complementary properties of an oil ; it is usually low viscosity and low film strength that go together.

For this reason in choosing a turbine oil it is necessary to consider the worst condition of bearing pressures for which the oil must be satisfactory. Thus a geared set will require a heavier grade of oil than a direct-coupled set. This type of set will, however, invariably incorporate some form of gear drive, and to gain the maximum advantage by the adoption of the lightest oil that a direct-coupled set will allow, it is necessary for the designer to proportion the governor drive gears to give low tooth pressures.

Another extremely important point arising out of this is that accuracy of cutting of the lightly loaded governor drive gears is a necessity if adequate lubrication is to be maintained. Minute errors in pitch and profile can give rise to high and almost instantaneous accelerations which result in momentary increases in tooth loads amounting to 800 lb or more over a tooth face width of as little as 2in. These increases in loading can break down the oil film between the gear teeth with pitting and rapid wear as the result.

As a matter of fact the successful lubrication of the small gears on a direct-coupled turbine, whether they be worm or helical spur drives, does present quite a problem, and it is frequently found that lubrication of these on one machine will be good while that on another, with identical gears is totally unsatisfactory. The reason for this may often be traced to vibration in the turbine shaft. The amplitude of the vibration need not be great, and, indeed, the machine may appear to run satisfactorily, but the effect of the small relative movement of the gear teeth is to shear the film of oil and permit metallic contact. Attention to the maintenance of the set to reduce vibration will result in the lubrication trouble being cured, and any consideration that might have been given to changing to a heavier grade of oil can be abandoned.

It is, however, evident that on a direct-coupled set the margin of safety, if it may be so expressed, in the deterioration of the oil is not very large, and that rapid wear of heavily loaded parts may occur if the oil is not maintained in first class condition. The danger is that on such sets, bearing temperatures may remain perfectly normal, while the oil deteriorates to an extent sufficient to permit gear wear. In sets that are running for long periods at a time, bearing temperatures are relied on to give evidence of satisfactory lubrication, the gears will not be examined and wear may continue to dangerous amounts without being detected. It is therefore very necessary to ensure that the oil is maintained free from acid and sludge so that its lubricating properties may remain unimpaired.

This brings us to the consideration of the causes of deterioration of a turbine oil.

One of the major causes of deterioration is oxidation. This oxidation is produced by the admixture of air with the fluid during its passage through the bearings, and its return to the oil tank. The rate of oxidation is greatly accelerated by rise of temperature, so that the adequate dissipation of the heat absorbed by the oil is of great importance, quite apart from the control of bearing temperatures. In fact, it is desirable to provide sufficient cooling to prevent oil temperatures from rising above 150 deg. Fah., when bearing temperatures up to 160 deg. Fah. may be regarded as safe. A rise in temperature of the oil to 170 deg. Fah. will be sufficient to double the rate of oxidation at 150 deg. Fah. A dangerous period from the point of view of oxidation of the oil is that just after the shut-down of a machine. The residual heat in the machine is conducted along the shaft at this time, and a rise of temperature of the journals occurs. The result is that the small amount of oil left in the bearings becomes oxidised at a much greater rate than is normal. When the machine is restarted the oxidation products are washed into the system, and form nuclei for the formation of sludge. In modern high-temperature machines, a barring gear is provided and for reasons of avoiding shaft deflections the machine is rotated slowly for a period of six hours or more after a shut-down. During this time the oil is circulated through the bearings by means of a flushing pump, with the oil coolers in normal service. This procedure automatically avoids the difficulty of journal temperature rise.

A problem can occur in providing adequate lubrication during the barring period. First of all the machine is hot and the oil therefore at its thinnest. Secondly, the barring speed is low and the effect of the shaft surface in building up an oil wedge is so reduced that "thin" film conditions of lubrication obtain and any interruption in the oil supply or drop in speed of the shaft will allow the oil film to break down and permit wear of the bearing surfaces.

The problem is solved by providing a reliable auxiliary oil pump, which can, if so desired, be interlocked with the barring gear so that the latter cannot be put into operation unless the oil supply has first been provided. Also, the barring gear itself is so designed that a peripheral journal speed of at least 20ft per minute is obtained since it has been found that such a speed will ensure maintenance of the oil film.

Many relatively high temperature machines are not provided with a barring gear, but it has been found very advantageous to circulate the oil through these machines by an auxiliary pump for some hours after a shut-down, keeping the oil coolers in service and, of course, supplied with water. An added advantage is that this procedure prevents any possibility of deformation of the white metal of the bearing bushes, due to temperature rise. In this connection it may be pointed out that the high-pressure bush of a turbine is only from 12in to 18in away from a high-temperature zone at 750 deg. Fah. or more, and that the white metal becomes plastic at little over 300 deg. Fah. It is therefore desirable to prevent any possibility of the white metal attaining the plastic temperature.

The greater the turbulence in the oil the greater is the quantity of air absorbed, but it is not possible to overcome the high degree of oil turbulence which exists in all steam turbines. The principal cause of this turbulence is the rapid change of velocities which exist in all bearing housings. The oil leaves the bearing at relatively high speeds at the shaft surfaces whence it is either flung against the stationary housing, or is picked up by the coupling where it is accelerated to an even higher velocity before suddenly coming to rest on the bearing housing. These conditions give rise to foaming and a maximum entrapping of air takes place.

Due to the ejector action of the oil passing down the return pipes, the air pressure within the bearing housing is below atmosphere, so that air is drawn in through the baffles and becomes entrained with the oil. Water vapour may also be drawn in and I propose to refer to this again later.

It can be seen from the points which have been mentioned that it is not possible to do very much by design to ameliorate the conditions of service as regards entrainment of air so that the chemical resistance of an oil to oxidation is very important. To give satisfactory service over a long period a turbine oil should be highly resistant to oxidation, and should also be of such a nature that foam does not form. Neither of these properties is inherent in the conventional highly refined turbine oil and it has been found that for operating temperatures of 750 deg. to 800 deg. Fah. the life of a conventional oil cannot be expected to exceed about 30,000 hours, while for higher

* South African Institution of Engineers, Johannesburg, December 11, 1947.

operating temperatures conventional oils are not suitable at all.

Developments in oil technology during the war period have, however, produced additives which are mixed with the oil in small quantities and effectively inhibit oxidation of the main body of oil and also very effectively prevent foaming.

By the use of these inhibitors, as they are termed, the life of the oil may be extended to an almost indefinite period.

New batches of oil, whether inhibited or not, often exhibit foaming characteristics, due to the presence of dissolved air and also small quantities of lighter fractions. Expulsion of the air and these lighter fractions may be accomplished more quickly and the foaming lessened by reducing the water supply to the coil coolers and so forcing up the temperature of the oil to its normal value. Competent supervision is essential during this period, as a dangerous temperature rise could easily occur. A somewhat slower but safer method is to pass the whole charge of oil through a centrifuge, heating it during the process to 150 deg. Fah.

(To be continued)

Continental Engineering News

Road-Traffic Subway in Trieste

In November, 1947, a traffic subway, the Galleria di Montebello, was opened in Trieste destined to link Piazza Foraggi and St. Ann, and to improve city communications congested by a considerable increase of traffic. The subway is 2400ft long, 39ft 6in wide, and 25ft 6in high.

It is concrete lined throughout, with cement rendering mixed with a waterproofing material. A considerable part of the subway was driven through the rock, and 82 tons of explosives were used.

Earthwork amounted to 175,000 cubic yards and 2400 cubic yards of timber were used for shoring the trenches. About 24,000 cubic yards of concrete were paced on the contract.

A Swiss Railway Bridge

A notable bridge was recently completed on the railway line between Geneva and La Praille and subjected to a test load.

The bridge, the Pont de la Jonction, crosses the rivers Rhône and Arve. It is composed of three concrete arches, of 199ft, 179ft and 158ft span. The headroom above water level is 82ft. A double-track decking, with a 33ft width, is carried on plain concrete arches, 25ft 10in wide. The arch thickness varies from 4ft 3in at the crown to 9ft 3in at the springings. They rest on two piers founded on caissons and two massive abutments. The caissons filled with mass concrete were driven by compressed air. Bridge spandrels are faced with natural stone. During construction timber arches were used as centering for the arch spans. During tests movable loads represented by four locomotives weighing a total of 400 tons were placed to produce the maximum stresses at various sections. The results were said to be quite satisfactory. After crossing the bridge, the railway line from Geneva to La Praille will enter de la Bâtie tunnel, to be driven on the left bank of the Rhône. Works for the construction of this tunnel, which will be 3500ft long, are proceeding. At the northern end tunnelling has progressed 770ft, while at the southern end the heading amounts to 1650ft.

New Dams in Spain

As previously mentioned in these notes, an important plan for the development of hydro-electric stations, destined to increase and improve the supply of electrical energy in the country, is now operating in Spain. Two dams, forming items of this programme, have been recently completed and officially opened. The Flix dam on the River Ebro, put in service on January 3, 1948, is 1300ft long. It retains 26 million cubic yards of water. Two tunnels, interconnected by a third one, shorten the course of the River Ebro, near the village of Flix, creating a head of 38ft. This water is led, with a discharging capacity of 14,000 cusecs, through penstocks to the generating station, equipped with four groups of turbo-alternators, rated at 57,200 h.p. The annual capacity of the Flix hydro-electric plant will be 200 million kWh, of which 10 million will be reserved for the State Railways, while 44 million kWh will be supplied to the Sociedad Electroquimica de Flix, the remaining energy, 146 million kWh, being utilised for public consumption.

The Ribesalbes hydro-electric plant, opened on January 20, 1948, includes a dam of the overflow type, 240ft long. The dam is equipped with three gates, electrically operated. It retains 540,000 cubic yards of water. A discharge tunnel, 2½ miles long, and penstocks lead water to the Ribesalbes power station. This station is equipped with two groups of turbo-alternators. The annual output of the plant will be 36 million kWh.

Railway Bridge Rebuilding in Italy

During the war Italian railways suffered very heavy damage, especially as regards bridges. About 4000 masonry, including concrete, bridges with an overall length of nearly 43 miles were either destroyed or damaged, while more than 800 steel bridges with an overall length of 22 miles were put out of service. Since the liberation of the country many bridges have been repaired or rebuilt.

Among the restored structures, the Desenzano viaduct and the Cremona bridge deserve special mention. The Desenzano viaduct, on the main line from Milan to Venice, was built in 1860. It crossed a deep valley by means of seventeen arches, each 55ft long, at a height of 98ft. The arches rested on masonry piers spaced at 72ft centres. The overall length of the Desenzano viaduct is 1250ft. The irrational shape of the arches, chosen only to suit the style of that time, gave many structural troubles, such as cracks in the piers. It was therefore decided to build an entirely new viaduct, consisting of concrete portal frames, having the same span as the old-fashioned tied arches. As the new structure is considerably lighter than the old one, the pressure on the foundations has been reduced by 40 per cent. About 11,000 cubic yards of concrete and 1250 tons of reinforcement were placed on the contract.

The Cremona bridge, one of the largest Italian bridges, has an overall length of 3100ft. It consisted of two independent bridges, one for railway traffic and the other for vehicular traffic. This steel bridge, of the lattice girder type, was composed of twelve spans. The structure was heavily damaged during the war. Owing to the shortage of steel in Italy, the authorities concerned decided to rebuild only the railway bridge. For this work Grey wide-flange beams, 3ft 3in high, were used, cantilevered out.

A New System of Airfield Runway Construction

Recently a new system of runways was demonstrated at the Melsbroeck airfield, near Brussels, where an experimental section, 245ft long by 165ft wide, was erected for the purpose. Instead of being formed of large slabs, measuring generally 82ft by 13ft, the new runway is composed of small interlocking blocks, made of vibrated concrete. The blocks, called " polycobloes " in French, are 5in thick and 8in square. No mortar or bitumen joints are used, the blocks being free to expand or contract. The blocks rest on a layer of gravel, 12in thick, through which rain water drains. Between the layer of gravel and the soil is interposed a light concrete foundation, 4in thick. With the new system it is possible to do repairs without special difficulty. The runway demonstrated at Melsbroeck has been designed by Professor L. Baes, of the Brussels University, assisted by Monsieur Macq, civil engineer.

Doubling the Saint Gothard Line

With the aim of developing traffic on the Lucerne-Milan line, the Swiss Federal Railways are doubling the St. Gothard line. Works on the section from Brunnen to Flüelen, one of the remaining parts of the St. Gothard Railway yet to be doubled, are now in good progress. The new line, 7¼ miles long, is divided into two sections, from Brunnen to Sisikon and from Sisikon to Flüelen.

On the grounds both of economics and engineering, works started first on the Sisikon-Flüelen section in 1940. In 1942 a tunnel between Stutzeck and Axenberg was pierced through compact rock. The shape and the lining of the new tunnel are similar to those of the existing one. On the Brunnen-Sisikon section the Alps are crossed by means of two tunnels, the Morschach and the Frohnalp tunnels. Works on this section were begun in October, 1944, and are now approaching completion. For a distance of 455 yards from the north portal the Morschach tunnel is a double-track structure, 28ft wide, then the line is forked into two lines, one crossing to a new tunnel, 17ft wide, and the other utilising the old one.

In addition to the construction of the tunnels, a ten-span concrete viaduct, with an overall length of 280ft, has been built near Brunnen station, as well as some other structures, destined to eliminate seven level crossings.

It is hoped that works, which include also improvement of the existing line, will be completed by the summer of 1948. The average cost of tunnelling was 2200 Swiss francs per metre (£115 per yard).

Cointrin Airport, Switzerland

Owing to a considerable increase in air traffic, works are now in progress in Switzerland for the construction of an airport at Kloten (Zurich Canton) and the modernisation of the Cointrin airport (Geneva Canton).

Works at the Cointrin airport, started in 1941, are now approaching completion. The airfield will be provided with a main runway, measuring 2200 yards long and 55 yards wide. This runway, consisting of reinforced concrete slabs, is founded on a layer of quarry gravel, 6in thick, laid directly on the soil, of great bearing capacity. The approach roads are 69ft wide. The airfield will be provided with a terminal building, a reinforced concrete framed structure, composed of a central hall and two wings, the whole having an overall length of 1600ft.

Large hangars for aeroplanes are also being built. These hangars will consist of a main section, 560ft by 195ft, flanked by an assembly hall, 260ft by 130ft. The roof of the main section is carried on steel trusses, spaced at 49ft centres, supported in turn on double-span steel lattice girders, each 280ft long. These girders rest on concrete pillars interconnected by concrete beams.

Stockholm Town Planning Competition

Because of rapid development of the city and with the object of planning improved communications between the southern and the eastern parts of the Swedish capital, the Town Planning Board of Stockholm has opened an international competition for the construction of a new traffic through-way. Stockholm, is situated on a number of islands, and the main object of the highway, called Osterleden, is to link the southern areas of the city, or Södermalm, with the eastern areas, or Ostermalm, by means of a direct highway.

The new artery will include a section connecting Södermalm with the island of Djurgarden by means of a bridge (with 1640ft span) over the Slatsjön inlet, or a tunnel driven under this sea arm; a highway section crossing Djurgarden; a connection between South Djurgarden and Ostermalm-North Djurgarden by a bridge or a tunnel across the Djurgardsbrunn inlet; and an extensive system of approaches. If the Saltsjön is to be spanned by a bridge, that structure should be provided with considerable navigational headroom (130ft). On the other hand, if the tunnel solution is selected, the upper part of the tunnel should be at least 42ft under the water level. The greatest traffic on the Osterleden route is estimated at 5500 vehicles per hour, including 30 per cent bicycles.

Industrial and Labour Notes

Iron and Steel Production

The British steel industry achieved a new production record during April, the weekly average output of ingots and castings being 293,900 tons, which represents an annual rate of 15,283,000 tons. In March, the annual production rate was 15,117,000 tons, and in April, 1947, when the effect of the fuel crisis was being felt, the annual rate of steel output was 12,294,000 tons. Since the beginning of the year, the output of the British steel industry has been steadily rising, and over the first four months has been at an annual rate of 15,016,000 tons. Pig iron production also increased during April, an average weekly output of 181,400 tons representing an annual production rate of 9,433,000 tons.

Commenting on the record steel output, the British Iron and Steel Federation says that the high level of production reflects the continued success of the home scrap drive. The record rate of scrap collection in this country has at last checked the fall in scrap and pig iron stocks. Pig iron production, the Federation adds, shows the benefit that is being secured from the new blast-furnaces, two of which have recently established European output records.

Industrial Targets

At his Press conference on Wednesday of last week, the Chancellor of the Exchequer, Sir Stafford Cripps, spoke of the progress that was being made towards the achievement of the export targets set out in the Economic Survey. He explained that the forecast of exports by commodity groups gave a total for the year 30 per cent higher by volume than in 1938, based on an increase of 25 per cent in the first six months and 36 per cent in the second. In the first three months of this year, the volume of exports was just over 26 per cent higher than in 1938, but that, Sir Stafford observed, was only the first step. In the second half-year the task would be harder, and by the end of the year the increase over 1938 had to be twice as great as in the first quarter.

The Chancellor went on to quote output figures of certain industries, including coal, steel, vehicles, machinery and shipbuilding, and cited examples of outstanding achievements of various firms and workers engaged in those and other industries. Summing up the evidence of increased industrial effort, Sir Stafford said that, provisionally, production in the month of February had been estimated as 24 per cent above the average for 1946, which compared with the record figure of 23 per cent in November, and which was higher than at any time since the war. The Economic Commission for Europe, Sir Stafford observed, had made some calculations which suggested that in the third quarter of 1947 industrial production in this country was 9 per cent above 1938, compared with an average for the United Kingdom and fourteen other European countries of 14 per cent below 1938, or 1 per cent below if Germany were excluded. The industrial output of this nation was, therefore, going up, the Chancellor concluded, although it could not be claimed from the figures given that it was yet going up fast enough.

Average Earnings in Industry

An inquiry was made by the Ministry of Labour in October, 1947, in order to obtain particulars of the average weekly earnings of manual workers employed in manufacturing industries generally and in some of the principal non-manufacturing industries of the United Kingdom. Information was provided by approximately 52,000 establishments employing, in all, nearly 6,000,000 workers. The particulars related to the last pay week in October, and a detailed survey of the results of the inquiry has been published in the latest issue of *The Ministry of Labour Gazette*.

According to this survey, the average earnings of the 6,000,000 workpeople in the last pay week of October, 1947, were: Men of twenty-one and over, 128s. 10d.; youths and boys, 51s. 2d.; women of eighteen and over (excluding part-time workers), 69s. 3d.; and girls, 44s. 4d. Compared with October, 1938, these figures indicate increases of 86, 99, 114 and 136 per cent respectively. Tables included in the Ministry's survey show the average earnings in the last pay week of October, 1947, in the various industries covered by the investigation. In the metal, engineering and shipbuilding industries, the average earnings were: Men, 140s. 3d.; youths and boys, 49s. 1d.; women, 73s. 9d.; and girls, 45s. 8d., which, compared with October, 1938, represent increases of 87, 88, 121 and 129 per cent respectively.

It is explained that since last October there have been increases in wage rates in a considerable number of the industries covered by the inquiry. In the first three months of this year, it is estimated that 1,975,000 workers received increases in their weekly wages aggregating £568,500.

Working Hours

The Ministry of Labour inquiry, referred to in the preceding note, also took account of the hours worked in various manufacturing and non-manufacturing industries in the last pay week of October, 1947. The figures which the Ministry has compiled include overtime and all periods during which workpeople were available for work and for which a guaranteed wage was payable. From them it is computed that the average hours worked in the last pay week of October, 1947, were as follows:—Men, 46·6 hours; youths and boys, 44·1 hours; women, 41·5 hours; and girls, 42·1 hours. Comparative figures for October, 1938, were 47·7 hours, 46·2 hours, 43·5 hours, and 44·6 hours respectively.

Taking the group of industries classified by the Ministry as "metal, engineering and shipbuilding," the average hours worked in the last pay week of October, 1947, were: Men, 46 hours; youths and boys, 43·2 hours; women, 41·3 hours; and girls, 41·6 hours. In October, 1938, the figures for the same group were 48 hours, 45·9 hours, 44·2 hours, and 44·7 hours.

The Confederation of Shipbuilding and Engineering Unions

The report of the engineering sub-committee of the Confederation of Shipbuilding and Engineering Unions, which was submitted to the annual conference at Weston-super-Mare last week, put forward the view that "the lack of a proper plan for engineering was retarding production." The sub-committee, it was stated, had submitted a memorandum to the Government setting out its suggestions on planning for the engineering industry.

The dual task still confronting the engineering industry, the report asserted, was the re-equipment of Britain's basic industries and those of her former suppliers of food and raw materials in Europe and Asia, and failure to concentrate on that had been responsible, to a considerable degree, for the present crisis. The main Government proposals for dealing with the crisis, the report continued, did not face up to the fundamental need. The output of engineering capital goods urgently required at home and for export was gravely handicapped by preoccupation with less essential production, by the absence of definite and well-organised production programmes, and by the failure to mobilise workshop enthusiasm and initiative. The sub-committee suggested that it was high time to create effective machinery for democratic planning. This should be designed to draw the organised workers into partnership, and, without adding to the Civil Service, to achieve a planned increase in the output of engineering goods so that the rate of re-equipment at home and the volume of exports could be enhanced. Furthermore, it was urged that this machinery should be designed to improve the organisation of engineering production and raise output per head.

The report disclosed that the sub-committee's memorandum had already been discussed with the Minister of Supply, Mr. G. R. Strauss, and reference to the matter was made by the Minister when he addressed the Confederation on Wednesday of last week. He spoke of the good relations between the unions and the Ministry of Supply, but regretted that he had not been able to accept in full the proposals made in the Confederation's production plan. There were, Mr. Strauss said, two principles which must be accepted. First, there must be at all levels the most effective participation of workers and their representatives in the management of industry, and, secondly, responsibility for ministerial action must remain in the hands of Ministers. That final responsibility could not be shared with any outside body.

Trade Disputes

There were 190 stoppages of work through industrial disputes reported to the Ministry of Labour during March, and 16 stoppages which began before March were still in progress in the early part of that month. As a result of these 206 stoppages, it is estimated that 63,000 workers were rendered idle during March and that 228,000 working days were lost. Of the 186 stoppages of work through disputes which ended during March, 68 lasted not more than one day; 48 lasted two days, 21 lasted three days, 26 lasted from four to six days, and 23 lasted more than six days.

In the first three months of this year there were 542 stoppages of work in the United Kingdom brought about through industrial disputes. In them, 146,300 workers were involved and the aggregate number of working days lost was 598,000. Of these stoppages, 309 occurred in the coal mining industry, involving 68,400 workers and causing a loss of 168,000 working days. In the engineering and shipbuilding industries there were 55 stoppages, in which 21,800 workers were involved, with an aggregate loss of 219,000 working days. In the corresponding three months of 1947, there were 484 stoppages of work through disputes, in which 167,400 people were concerned and through which 683,000 working days were lost.

Redeployment of Labour

The subject of manpower trends and the redeployment of labour was debated in the House of Commons on Tuesday evening of last week. Mr. Swingler, in introducing the matter, said that the redeployment of labour in 1948 was a key question and one which was becoming harder rather than easier as time went on.

In winding up the debate, the Parliamentary Secretary to the Ministry of Labour, Mr. Ness Edwards, referred to the reduction in employment since 1939 in those industries which were at present undermanned. Taking the longer-term view, he said that, roughly speaking, this country would be 500,000 workers short in 1951, compared with 1946. Mr. Ness Edwards went on to point out that there were several industries in which manpower had increased, amongst them "Metals and Engineering," which at the end of 1947 had 690,000 workers more than in 1939. As to the way in which the present situation was being handled, he said that in the eight weeks ended March 17th 750,000 people were placed in jobs by the Ministry of Labour. Of every four additional workers in the manufacturing side of the country's activities, three persons had taken first-preference jobs in the industries which were undermanned.

French Engineering News

(From our French Correspondent)

An International Congress of Mechanical Production is to be held in Paris from September 13th to 18th. It is being organised by the Mechanical Industries General Syndicate, in co-operation with similar groups in England, Belgium, Holland, Sweden and Switzerland. Industrial questions will be treated rather than purely scientific subjects, particularly new methods of working metals and new manufacturing techniques. Delegates will be invited to visit factories in the Paris region and there will be excursions to other regions.

Exports by the mechanical industries in 1947 amounted to 8,200,000,000 francs, compared with 950,000,000 in 1938. Automobile exports over the same period increased from 504,000,000 to 6,100,000,000 francs. The following are some of the more important exports in 1947: textile machinery, 680,000,000 francs; hand tools, agricultural tools and mechanical tools, 585,000,000 francs; engines, turbines and compressors, 520,000,000 francs; agricultural machinery, 430,000,000 francs; machine tools, 415,000,000 francs; printing machinery, 230,000,000 francs, and rolling stock, 165,000,000 francs. Most of these exports went to the Benelux countries, with Switzerland, Holland, Argentina and Brazil following. Altogether, 5 per cent of the total production was exported.

* * *

Unless there is an appreciable drop in the cost of living in France, there is likely to be considerable labour trouble shortly. There have already been threats of strikes at Peugeot, Hispano, Morane and other works and Monsieur Croizat, leader of the metal workers, has demanded that the Metal Federation should negotiate directly with the Employers' Federation on the question of salaries. The President of the Employers' Federation, however, has called upon industrialists to work for a price reduction by reducing production and distribution costs as far as possible.

* * *

Although production continues to improve there are still appreciable delays in the delivery of steel products. Thus, commercial steel is delivered within five to eight months, girders in six months, wire in four to five months, narrow strip in six to seven months, and medium sheet metal in twelve to sixteen months. It is hoped that these delays will be cut down as more coal is available and new machinery comes into service.

Out of the 5,200,000 tons of steel products distributed in 1947, 2,160,000 tons went to nationalised industries. The coal mines received 463,000 tons, electricity 301,300 tons, the S.N.C.F. 521,500 tons, Renault 106,300 tons, and other public services 765,700 tons. Allocations were not considered satisfactory by the recipients, however. The S.N.C.F. needs 2,000,000 tons to re-establish its pre-war situaton, and the delay is the cause of the shortage of rolling stock. Allocations to Electricité de France amounted to 30 per cent of the demand; nine-tenths was used for new construction. The coal mines asked for double their actual allocation. In spite of this apparent disparity, it is rumoured that permits for ferrous metal will be abolished in July or October, 1948.

* * *

The government has decided to increase allocations of steel to the automobile industry progressively. For the second quarter, the industry will receive 160,000 tons, an increase of 30,000 tons over the first quarter. During the last three months of 1947, only 87,000 tons was allocated for automobile construction, production for that year being only 30 per cent that of 1938. It is hoped that with the increased allowance of steel, this percentage will be doubled. At the moment the industry can produce 12,000 vehicles a month and it is thought this could be increased to 15,000 units.

Light lorries can already be sold without permit and controls on lorries are expected to be lifted very shortly. Private cars will still be controlled, however, owing mainly to the shortage of sheet metal for bodywork.

Notes and Memoranda

Rail and Road

MOTOR VEHICLE PRODUCTION AND REGISTRATION.—The Society of Motor Manufacturers and Traders records in its latest statistical bulletin that 32,349 motor cars were produced in March in the United Kingdom. The number of commercial vehicles completed during the month was 15,457. New registrations in Great Britain in February were 8535 private cars and 10,035 commercial vehicles.

CANADIAN PACIFIC RAILWAY.—The annual report of the Canadian Pacific Railway Company for 1947 shows that freight traffic receipts were 14·8 per cent higher than in 1946, but that passenger traffic earnings were 11·1 per cent lower. Maintenance work included the complete overhaul of 767 locomotives, 28,379 freight wagons and 1294 passenger vehicles, and at the end of the year 98·2 per cent of the company's freight wagons and 93·5 per cent of its locomotives were in serviceable condition. Another item mentioned in the report is that the Sperry detector car, used in the examination of rails for hidden defects, tested 8090 miles of track during the year.

Air and Water

THE ROSS DAM.—It is expected that the third stage in the construction of the Ross dam on the Skagit River, Washington, will be completed during this year. There will then remain the fourth and final stage to bring the dam to its full height of 675ft.

SWEDISH SHIPBUILDING.—A report on shipbuilding in Sweden, presented at a recent meeting of the Swedish Committee of Lloyd's Register, shows that sixty vessels, aggregating 249,700 gross tons, are at present under construction. Another 168 vessels, aggregating 999,015 tons, are on order.

H.M.S. "ALAMEIN."—The flotilla leader, H.M.S. "Alamein," which has been constructed by R. and W. Hawthorn, Leslie and Co., Ltd., at the Hebburn Shipbuilding Yard, was officially inspected on April 30th, by Captain J. E. Sissmore, D.S.C., R.N., Captain Superintendent of Contract-Built Ships and commissioned under the command of Lieut.-Commander H. T. Harrel, R.N. H.M.S. "Alamein" has a displacement of about 2200 tons, with a two-shaft arrangement of geared turbines of a total s.h.p. of 50,000. Her armament consists of twin 4·5 q.f., twin 40mm Bofors, and 21in torpedo tubes.

H.M. SHIPS FOR THE CHINESE NAVY.—The Admiralty states that the cruiser, H.M.S. "Aurora," familiarly known as the "Silver Phantom," and the "Hunt" class destroyer, H.M.S. "Mendip," are to be handed over to the Chinese Navy at Portsmouth on May 19th. H.M.S. "Aurora" is a cruiser of the "Arethusa" class, and has a displacement of 5270 tons. She is 500ft in length, with a beam of 51ft, and mounts six 6in guns in addition to 21in triple torpedo tubes and considerable secondary armament. The "Aurora" was completed in 1937 at the Royal Dockyard, Portsmouth, her machinery being installed by Wallsend Slipway and Engineering Company.

Miscellanea

BLIND WORKERS.—An illustrated brochure, entitled "Skilled Hands," has been issued recently by the National Institute for the Blind, and presents convincing evidence, if any is needed, of the ways in which many hundreds of blind persons are now filling a useful place in industry. As well as following commercial and clerical occupations, blind workers are now to be found in the machining, assembly and inspection departments of many engineering concerns. The brochure tells also of the work that is being done by the blind in the artificial jewellery, joinery, radio, dyeing and cleaning, and photographic industries. A Special Investigation and Commercial Appointments Department of the National Institute for the Blind, 224, Great Portland Street, London, W.1, deals with the placing of blind workers in industry.

IMPROVED CLOCKWORK DRIVING MECHANISM.—We were recently invited by G. Oxenford and Co., of Fulwood House, Fulwood Place, High Holborn, London, W.C.1, to inspect examples of the Hobbs-Oxenford helical spring drive, which is being applied to toys, models and mechanisms requiring spring operation. In contrast to the usual flat spring, the driving member is a helical spring, mounted on an extending barrel. When it is wound up the ends of the drum move out, accommodating the smaller diameter and longer length of the spring, while as the spring unwinds and gives up its energy, the ends come together. The arrangement, it is claimed, relieves the spring coils of end tension, thereby increasing the efficiency of the drive so that nearly all of the energy impressed is given out without loss. The ratchet wheel slides on a square winding shaft, and its teeth are in contact with a longitudinally arranged spring pawl in all positions. The gear-driving wheel at the other end of the barrel is furnished with a long screwed boss, which engages an internally threaded drum attached to the ratchet wheel. A tubular sleeve, over the gearwheel threaded member, forms a seating for the spring. In winding, the ratchet wheel is turned and the helical coils of the spring contract in diameter and increase in number as they are accommodated by the extension of the barrel. When unwinding, as the spring gives up its stored energy the threaded members restore the barrel to its normal length. Means are provided to prevent the overwinding of the spring, while at the same time it is possible to preload the spring, thereby reducing the number of turns needed to obtain a given driving effort. Drives for various powers have been designed.

RESISTANCE WELDING.—The annual general meeting of the Resistance Welding Machine Section of B.E.A.M.A. was held in London recently, and Mr. R. W. Ayers (Managing Director, Sciaky Electric Welding Machines, Ltd.) was re-elected chairman for the year 1948–49. Presenting his report for the past year, Mr. Ayers referred to the activities of the section in a number of matters of common interest to the industry as a whole. Exports, which were negligible before the war, had increased progressively and had been more than doubled during the past year. Furthermore, this country was virtually self-supporting in resistance welding machines, for imports represented less than ½ per cent of total sales in an industry that had a turnover of £1,250,000 per annum. The future of the industry depended, said Mr. Ayers, on two main lines of action—development and research, and an increase in the knowledge of resistance welding in industry generally.

A.M.I.MECH.E. EXAMINATION.—The Institution of Mechanical Engineers has issued revised "Rules for Examinations and for Submission of Theses." These rules give effect to the Council's decision to make provision for an examination in "Automobile Engineering" as an optional subject in Section B of the associate membership examination, thus continuing the policy which was announced by the Institution of Automobile Engineers prior to the amalgamation. From October, 1948, therefore, Section B of the associate membership examination will consist of two compulsory papers on Theory of Machines, and Properties and Strength of Materials; and one selected paper to be chosen from Heat Engines I: Steam and the Steam Engine; Heat Engines II: Internal Combustion Engines; Hydraulics and Hydraulic Machinery; Electrotechnology; Metallurgy; Aeronautics; Metrology and Machine Tools; and Automobile Engineering.

THE LONDON ASSOCIATION OF ENGINEERS.—There was a large attendance of members and guests at the 96th Anniversary Festival Dinner of the London Association of Engineers, which took place at the Connaught Rooms, London, on Friday evening last. Lord Dudley Gordon was in the chair for the occasion, and was supported by Mr. C. F. Kingham, President of the Association. Following the loyal toasts, Lord Sempill proposed "The Engineering Industry." He said that a vital factor in the part which the industry had to play in the task of economic recovery was complete unity of purpose and he cited examples of various concerns which by determined and united effort had progressively increased their production. Another important point to remember, Lord Sempill observed, was that internationally the scientific and technical fields must not be restricted. He submitted that engineers wanted a freer atmosphere in which to carry on their work. Engineer Vice-Admiral D. C. Ford, Engineer-in-Chief of the Fleet, acknowledged the toast, after which Lord Piercy proposed "His Majesty's Ministers." To this, the Minister of Fuel and Power, Mr. Hugh Gaitskell, responded and in the course of his speech directed attention to the serious world shortage of oil. It was, he said, caused by an astonishing increase in demand, which in the U.S.A. had risen from a consumption in 1938 of 300 gallons per head of the population to just over 500 gallons per head at the present time, compared with eighty gallons a head in Britain. The greatest oil resources, the Minister added, were in the Middle East, but it would take time before refinery capacity and tankers were ready, and for the next few years oil supplies would be difficult. Among the other speakers were Lord Dudley Gordon, who proposed the toast of "The London Association of Engineers"; Mr. C. F. Kingham, Mr. W. J. Haycroft, Lieut.-Cneral F. C. Wrisberg, the Dean of St. Paul's, and Sir Ian Stewart Richardson.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Chemical Society

Thursday, May 20th.—Burlington House, Piccadilly, W.1. Victor Moritz Goldschmidt Memorial Lecture, J. D. Bernal. 7.30 p.m.—University College Hall. "Kinetics of Some Organic Halogenation Reactions," R. P. Bell. 6 p.m.

Friday, May 21st.—King's College, Newcastle-upon-Tyne, 1. "Modern Theories of the Mechanism of Drug Action," A. R. Todd. 5 p.m.

Incorporated Plant Engineers

Wednesday, May 19th.—WESTERN CENTRE: Grand Hotel, Bristol. "Fans and Fan Appliances." K. L. Whitaker. 7.15 p.m.

Thursday, May 20th.—LIVERPOOL CENTRE: Grosvenor Museum, Chester. Film by Babcock and Wilcox on "Chain Grate Stokers." 7.30 p.m.

Institute of Navigation

Friday, May 21st.—Royal Geographical Society, 1, Kensington Gore, S.W.7. "Meteorology in Aviation: Is It Obsolete?" Francis Chichester. 5.30 p.m.

Institution of Electrical Engineers

Friday, May 21st.—MEASUREMENTS SECTION: Savoy Place, Victoria Embankment, W.C.2. "Great Personalities in the Fields of Electrical and Magnetic Measurements," J. T. Macgregor-Morris. 5.30 p.m.

Institution of Mining and Metallurgy

Thursday, May 20th.—Geological Society, Burlington House, W.1. Annual General Meeting. Part I (Members and Associates only). 4 p.m. Part II (Open Session), Presidential Address, S. E. Taylor. 5.15 p.m.

Institution of Structural Engineers

Wednesday, May 19th.—YORKSHIRE BRANCH: Great Northern Hotel, Leeds. Annual Meeting. 6.30 p.m.

Junior Institution of Engineers

To-day, May 14th.—Royal Society of Arts, John Adam Street, Adelphi, W.C.2. "Coal—Oil—Chemicals," J. G. King. 6.30 p.m.

Royal Institution of Great Britain

To-day, May 14th.—21, Albemarle Street, W.1. "The *Rôle* of Chemistry in Combating Tropical Diseases," Sir Ian Heilbron. 9 p.m.

Royal Statistical Society

Wednesday, May 19th.—N.E. GROUP: Newcastle Chemical Industries Club, 18, Lovain Place, Newcastle-upon-Tyne. "Experiments in Industrial Chemistry," K. A. Brownlee. 6.30 p.m.

Thursday, May 20th.—TEES-SIDE SUB-GROUP: William Newton School, Norton, Stockton-on-Tees. "The Use of the Factorial Experiment for Investigating Chemical Processes," K. A. Brownlee. 7 p.m.

Catalogues

MORGAN CRUCIBLE COMPANY, Ltd., Battersea Works, Battersea Church Road, S.W.11.—Booklet dealing with the Morgan power-tilted, lip-pouring crucible furnace.

RICHARDSONS, WESTGARTH AND CO., Ltd., Northumberland Engine Works, Wallsend-on-Tyne.—Illustrated booklet containing the company's war history.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., Trafford Park, Manchester, 17.—Descriptive leaflet 651/1–1, giving a general survey of "Seascan" merchant navy radar equipment.

KEEN INDUSTRIAL SERVICES, Ltd., Lindsey Street, Epping, Essex.—Brochure describing Keen multi-directional and dual directional conveyor chains and mechanical handling equipment.

STILLITE PRODUCTS, Ltd., Sardinia House, Kingsway, W.C.2.—Technical data catalogue dealing with industrial insulation, low-temperature insulation, building insulation and stillite filter materials.

RENOLD AND COVENTRY CHAIN COMPANY, Ltd., Renold Works (P.O. Box No. 5), Didsbury, Manchester. Illustrated catalogue, "Renold Chains for Adaptability and Versatility," Ref. No. 316/211.

E. H. JONES (MACHINE TOOLS), Ltd., Edgware Road, The Hyde, N.W.9.—Folders describing the C.V.A. 10-ton dieing machine, high-speed precision tapping machines and vertical milling and die-sinking machine.

Contracts

THE TURKISH POST, TELEGRAPH AND TELEPHONE DEPARTMENT has placed a contract with W. T. Henley's Telegraph Works Company, Ltd., for telephone cables required for development schemes at Istanbul, Ankara and Izmir. The value of the contract is approximately £300,000.

Personal and Business

MR. E. A. EVANS, M.I.Mech.E., has been elected President of the Institute of Petroleum.

MR. C. T. MORRALL has been appointed sales director of Frederick Kay (Engineering), Ltd.

MR. E. H. BALL has been appointed a director of the Metropolitan-Vickers Electrical Company, Ltd.

MR. F. G. GLOSSOP has been appointed production director of the North-Western Divisional Coal Board.

LIEUT.-COMMANDER RICHARD FAIRTHORNE, R.N. (Retd.), M.I.E.E., has been elected President of the Institution of Engineering Inspection. Mr. J. A. Harding and Mr. A. Vernon Watson have been elected Vice-Presidents.

THE BRITISH ALUMINIUM COMPANY, Ltd., announces the following appointments:—Mr. H. H. Cundell, sales manager; Mr. A. W. Langham, sales planning manager; Mr. E. E. Spillett, development manager; and Mr. P. S. W. Swabey, assistant development manager.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of report	Title	Post free s.	d.
B.I.O.S.:			
1558	German Acetylene Chemical Industry: Miscellaneous Research Items, I.G. Farbenindustrie ...	6	8
1578	Manufacture of Prepared Tracing Papers and Sectional Papers ...	2	8
1597	Phthalic Anhydride Manufacture in Germany	7	2
1608	The Manufacture of Edible Gelatin in Germany	3	8
F.I.A.T.:			
1070	Technical and Scientific Developments related to the Asbestos Industry in Germany	4	8
1127	A Report on the Flexible Shaft Industry in Germany	5	8
1163	The Telephonograph Recording System: Report in German ...	5	8
B.I.O.S.:			
JAP/PR/86...	Vibration and Flutter Methods Employed by the Japanese ...		10
JAP/PR/89...	Structural Requirements and Techniques Used in Design of Japanese Aircraft	1	1
JAP/PR/324	Measurement of Velocity of Detonating Gas (Explosive) ...	1	1
JAP/PR/902–903	The Raw Aluminium Industry of Japan	6	8
JAP/PR/921	Japanese Explosives	2	2
JAP/PR/1305	Japanese Fuels and Lubricants: Progress in the Synthesis of Liquid Fuels from Coal	30	8
JAP/PR/1468	Metallurgical Examination of Japanese Homare—II Aircraft No. 11,515	8	3
JAP/PR/1485	Metallurgical Examination of Two Japanese Aircraft Bank Turn Indicators	3	8
B.I.O.S.:			
1048	German Acetylene Chemical Industry. Acetylene and Synthesis Gas from Hydrocarbons	8	3
1313	German Methods of Production of Amorces and Sundry Pyrotechnic Stores	1	1
1390	The Manufacture and Use of Jacquards and Jacquard Card Punching Machinery in Germany	1	7
1441	The German Synthetic Ammonia Industry in the Western Zones	10	3
1492	German Scientific Films: Report on the Use of Educational, Medical and Industrial Films in Germany	3	8
1583	"Lefa" Sheet Leather Board from Scrap	1	1
1600	Cellulose Acetate Flake and Acetic Anhydride	16	4
1618	Manufacture of Monoalkyl Ethers of Ethylene Glycol and of Diethylene Glycol	5	2
1619	Diethylene Glycol Diethyl Ether (R.300) Preparation	1	8
1621	German Shipbreaking Methods ...	6	2
F.I.A.T.:			
727	The Krupp-Renn Plant at Salzgitter	1	7
1147	A German Universal Condenser Microphone...	1	1
1183	Compensation of Ground Current Through Petersen Reactors and their Application in the Bewag 30-kV Network	2	1
1184	Fourdrinier Wire and Wire Cloth	1	7
B.I.O.S.:			
JAP/PR/775	Japanese Metallurgical Specifications: Iron and Steel, Special Steels, Special Non-Ferrous Alloys	2	2
JAP/PR/914	Japanese Fuels and Lubricants: Fundamental Hydrocarbon Research	10	3
JAP/PR/1292	Japanese Propellants: Research on Non-Volatile Solvent Powders	4	2
JAP/PR/1431	Tungsten and Molybdenum Metallurgy of Japan	2	8
JAP/PR/1465	Metallurgical Examination of Landing Wheel and Strut, Wing Section and Components from Japanese Aircraft "Francis"...	4	2
JAP/PR/1466	Metallurgical Examination of Japanese "Sakae 12," Engine No. 124676...	6	2
JAP/PR/1482	Metallurgical Examination of Landing Gear Strut, Landing Wheel and Tail Wheel Strut Assembly from Japanese Aircraft "Betty"	4	8
JAP/PR/1498	Metallurgical Examination of Two Japanese Oxygen Cylinders ...	2	2
1324	German Radio Frequency Cables	12	10
1527	The Use of Rubber Dies in Producing Laminations from Electrical Steel Sheets	2	8
1589	Paper Pulp Moulding Industry in Germany	2	1
1614	Tungsten Carbide Tipped Percussion Drill Bits	2	8
1628(Section1)	German Hand Tools Industry: Files and Rasps...	11	4
1636	Berzelius Metallhutten G.m.b.H., Duisburg-Wanheim: Manufacture of Sulphuric Acid	2	1
F.I.A.T.:			
674	Heavy Duty Diesel Engines Manufactured by M.A.N. (Maschinenfabrik Augsburg-Nurnberg)	5	2
1023	Manufacture of Antipyrine and Pyramiden at I.G. Farbenindustrie A.H. Hoechst: Pharmaceutical Products...	7	2
1158	Some Wartime Experiences of Berlin Power and Light Co. (Bewag)	3	2
1199	The Manufacture of Vinyl Chloride by Means of Liquid Catalysts	3	2
1203	Utilisation of Oxygen in the German Iron and Steel Industry	3	2
B.I.O.S.:			
JAP/PR/1223	Radio Direction Finding Developments at 2nd Naval Research Laboratory, Japan	1	1
JAP/PR/1432	Iron and Steel Metallurgy of the Japanese Empire	4	8

Technical Information and Documents Unit, German Division, Board of Trade, 40, Cadogan Square, S.W.1, which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

Launches and Trial Trips

CALEDONIAN COAST, twin-screw coastal liner; built by Hall, Russell and Co., Ltd., for The Aberdeen Steam Navigation Company, Ltd.; length 265ft, breadth 40ft, depth 23ft 6in. Engines, two eight-cylinder British Polar engines, developing 2560 b.h.p. Trial trip, April 19th.

KASIMBAR and KAL OEKOE, motorships; built by Netherland Dock and Shipbuilding Company for Ministry of Transport; length 80·16m, breadth 13·10m, depth 8·18m. Engines, "Werkspoor" five-cylinder ships' diesel motor, direct reversible, developing 1300 b.h.p. Launch, March 20th.

HERTFORD, twin-screw motorship; built by Vickers-Armstrongs, Ltd., for New Zealand Shipping Company; length 530ft, breadth 70ft, depth 39ft; gross tonnage 11,150. Engines, twin five-cylinder Vickers-Doxford opposed-piston oil, developing 12,800 b.h.p. Launch, March 24th.

SALAMANCA, motor cargo liner; built by Harland and Wolff, Ltd., for the Pacific Steam Navigation Company; length 467ft, breadth 62ft 6in, depth 30ft 9in; gross tonnage 7000. Engines, double-acting eight-cylinder two-cycle, with cylinders 620mm bore by 1400mm stroke. Trial trip, March 20th.

IMPERIAL STAR, refrigerated cargo liner; built by Harland and Wolff, Ltd., for the Blue Star Line; length 540ft, breadth 70ft, depth 43ft 4½in; gross tonnage 13,500. Engines, two sets of reversible two-cycle, double-acting Harland-B. and W. diesel, with eight cylinders, 620mm bore by 1400mm stroke. Trial trip, March 12th.

BRITISH CHIVALRY, motor vessel: built by Blythswood Shipbuilding Company, Ltd., for British Tanker Company, Ltd.; length 515ft, breadth 69ft 6in, depth 37ft 6in, deadweight 16,000 tons. Engines, six-cylinder Barclay Curle-Doxford opposed piston, two-stroke cycle, airless injection, reversible oil, with cylinders 670mm bore by 2320mm combined stroke developing 6400 b.h.p. Launch, April 27th.

A Seven-Day Journal

A Model Exhibition

THE Jubilee Exhibition of the Society of Model and Experimental Engineers, which opened at the Imperial Institute, South Kensington, London, on Thursday, May 13th, affords ample evidence of the enthusiasm with which the model maker has pursued his interesting hobby for far longer than even the fifty years the Society has been in existence. Among the models to be seen are some made by the enthusiasts of a century ago, and their work has set a standard by no means easy to equal, let alone excel, by the present generation, despite the vastly improved facilities. The high standard of workmanship cannot fail to impress even the most uninitiated visitor to the exhibition. It shows that the true model maker—whatever his chosen career or business—has an inherent skill as an engineer. Despite the very wide range of model components now available it is interesting to note that the true model maker still prefers to make practically every part of his own model. The members of the Society have not only been satisfied to build beautiful working models, but they have also designed and built some very interesting plant on which the products of their labours can be tested on similar lines to the commercial originals. This equipment includes plant for testing small steam and petrol engines. Recently the Society developed and built a locomotive test bench designed to provide fully comprehensive data on model locomotives under actual running conditions. On this bench, which is to be seen in operation at the exhibition, model locomotives from 2½in to 5in gauge with wheel arrangements from 0–4–0 to 4–8–2+2–8–4 can be accommodated and tested. The exhibition will remain open daily until Saturday, May 22nd, and all who are interested in craftsmanship and engineering will find a visit both entertaining and instructive.

London-Bradford Express Derailment

IT is with deep regret that we have to record another serious railway accident, which up to the time of writing has resulted in eight deaths and injuries to about fifty people. The 11.45 express passenger train from St. Pancras to Bradford, which was headed by two locomotives, was derailed at Wath-on-Dearne, near Rotherham, at about 3.52 on Tuesday afternoon, May 18th. At the point at which the derailment took place the line runs through the yard of the Manvers Main Colliery on a 20ft embankment. Six coaches were reduced to wreckage, four lay at angles to the track, and others were reared on end. Three of the four lines were blocked, and it will be some time before they can be cleared. One of the engine drivers, Mr. Bert Wiltshire, has died from injuries received. When the accident occurred the colliery officials quickly organised help. The exact cause of the derailment is not yet known, but indications certainly seem to be that the track failed. It has been suggested that it became distorted owing to the heat of the sun. An official Ministry of Transport inquiry into the cause of the accident will be held in due course.

North-Western Electricity Board Tariffs

AT a Press conference last week, the Chairman of the North-Western Area Electricity Board, Mr. George Gibson, made a statement dealing with the proposals for adjusting tariffs in that area. Mr. Gibson explained that estimates received from the seventy-six undertakings now absorbed in the area indicated that, if tariffs remained as they were, there would be a collective deficit of nearly £1,000,000 on the year's present working. To reduce the foreshadowed deficit on twelve months' working by some £500,000, the Board therefore proposed to make certain tariff adjustments. These changes would affect domestic and some other non-industrial supplies which were not subject to a clause relating the price of electricity to the cost of coal. Accordingly, on domestic two-part tariffs the fixed quarterly charge would remain unchanged, while the running charge would be increased to ¾d. per unit. As a concession to rural consumers the surcharge to users in outlying districts would be discontinued wherever the unit price was raised. Meter rents would no longer be charged on tariffs affected by the increase. At the same time, it was proposed to reduce lighting flat rate tariffs where these exceeded 6d. per unit for quarterly accounts and 6¾d. per unit in the case of prepayment consumers. It was intended that these tariffs should come into force as soon as practicable after bills based on the next meter readings. Mr. Gibson went on to give the reasons for these changes, which were the first step towards more equitable charges. A thorough analysis of all tariff structures was now proceeding, and the Board's aim was gradually to harmonise, unify and standardise the areas tariffs as far as possible.

Midlands Engineering Historical Survey

IN January, 1947, an appeal by the Newcomen Society and the Birmingham Common Good Trust was made for information regarding items of engineering historical interest in the Midlands. A good response has been forthcoming, and with the interest of all the leading professional societies an interim report (1948) has just been issued by Mr. W. K. V. Gale, the Hon. Secretary of the Newcomen Society, Midland Branch, at 3, Halton Road, Boldmere, Sutton Coldfield, Warwickshire. It gives notes of the principal items disclosed and an indication of some of the information required. Copies will gladly be sent to those who are interested. Among the boilers we note that a "haystack" boiler has been discovered, that externally fired egg-ended boilers are still in use at Dudley and that "Rastrick" vertical fire-tube boilers are still in service. Matthew Boulton's house stands and is in good repair. Information is required concerning the history of the blast-furnace, bolts, nuts and other mechanical fastenings, tools and equipment used in Birmingham trades, dies and patterns, domestic workshops, needle manufacture and the making of silver plate ware. Interesting maps and plans and engineering drawings are also needed. Among the prime movers notified are a pair of McNaught compound beam engines, manual type fire pumps and an 1880 Crossley-Premier positive-scavenge gas engine, and also an early 1872 gas engine. Several good examples of pumping engines by Boulton and Watt, and a Newcomen converted engine with condenser have also been found. Among the machine tools, a fine face-plate lathe, a very early side planer and an old radial drilling machine have been disclosed.

Water Supply and Sewage Arrangements for New Towns

IN letters from the Minister of Town and Country Planning, Mr. Lewis Silkin, to the local authorities and others concerned with the establishment of new towns at Hatfield and Welwyn, it is pointed out by the Minister that problems arising from the provision of an adequate water supply and of efficient sewage disposal arrangements, as far as they affect the River Lee and London's water supplies, were referred to by the Lee Conservancy Catchment Board and the Metropolitan Water Board at the recent local public inquiry. Both were concerned with the effects upon the river of extracting from its sources in the chalk the water necessary for the new town, and discharging additional sewage effluent into it. The Minister says he is fully aware of the necessity of safeguarding such an important source of London's water supplies, and he appreciates the urgent need for an adequate and satisfactory scheme of sewage disposal in the Lee Valley. Consultations with the Ministry of Health and other interested parties on the various development schemes in the Lee Valley have already begun, and will continue with due regard to this new project. The Minister is clear on the advice he has received that a satisfactory conclusion can be reached. The Lee Conservancy Catchment Board also raised the matter of the possibility of increased silting of water courses, and the need for larger and better protected drainage channels as a result of the accelerated flow of storm water from the new town. The Minister recognises the need for early consultation with the Catchment Board on questions of engineering and of cost, and will instruct the Development Corporation accordingly. He is advised that there is no reason to anticipate any difficulty on this score.

National Coal Board Changes

ON Thursday evening, May 13th, it was announced by the Ministry of Fuel and Power that Sir Charles Reid, the production member of the National Coal Board, had resigned, following a disagreement with the Board about certain arrangements it is making to review its organisation. The Minister has appointed Sir Geoffrey Vickers, V.C., to be a member of the Board to fill the vacancy. The Board has appointed Sir Robert Burrows, who became a member on May 1, 1948, to be the chairman of a committee which will take stock of the position reached in the development of the Board's organisation and advise it whether any improvements can be made. The Board has decided to draw other members of this committee from outside its number, and it has accordingly invited Sir Mark Hodgson and Sir Charles Renold, both of whom have agreed to serve. Sir Mark Hodgson is the General Secretary of the United Society of Boilermakers and Iron and Steel Shipbuilders, and President of the Confederation of Shipbuilding and Engineering Unions, from which posts he is shortly retiring. Sir Charles Renold is chairman of the Renold and Coventry Chain Company, Ltd., and President of the British Institute of Management.

International Welding Congress

BY invitation of the Institut Belge de la Soudure, the inaugural meeting of a new international body, the International Institute of Welding, will be held in Brussels from June 8th to 11th next. It is expected that eighteen countries will be represented. The following programme has been arranged. Tuesday afternoon and the whole of Wednesday will be devoted to papers, and on Thursday a number of works visits have been arranged, while on Friday the Governing Council of the new Institute will hold its first meeting. The following papers have been promised:—On Tuesday, June 8th, "The Possibilities of Determining and Relieving Residual Stresses," by Monsieur Walter Soete; "Scientific Studies with Reference to the Applications of the Oxy-acetylene Flame," by Monsieur Willy Bonhomme; and "The Detection of Defects in Welded Construction," by Monsieur Georges Homes. On Wednesday, June 9th, "The Present Position on Residual Stresses in Welded Structures," by Mr. R. Weck (Great Britain); "Oxy-acetylene Pressure Welding," by Monsieur C. G. Keel (Switzerland); "Evolution of Metallurgical Problems in Welding: Examples of Hardening Phenomena," by Professor A. Portevin and his collaborators (France); and "Mathematical Treatment Yields Explanation of Brittle Fractures," by Professor F. K. Th. van Iterson (Netherlands). The official languages of the conference will be English and French. The movement for the establishment of the International Institute began at a meeting of the Dutch Welding Society in Utrecht last summer. Those intending to take part in the Brussels conference are invited to communicate with the secretary of the provisional committee, Mr. G. Parsloe, the Institute of Welding, 2, Buckingham Palace Gardens, London, S.W.1.

Graphical Methods for Flow-Net Diagrams

By S. LELIAVSKY BEY, Ph.D., M.I.C.E., M.A.S.C.E.*

No. II—(*Continued from page 465, May 14th*)

TANK EXPERIMENT FOR ESNA BARRAGE

FIG. 15 shows a flow line obtained experimentally by means of the usual glass-tank method. The model experimented with was arranged in this case to represent (to a scale of one to fifty) the design of the floor for the strengthening of the Esna Barrage on the Nile, in Upper Egypt (one from among several alternatives considered for a two million pound project).

A few minutes after the photo had been taken the glass plate broke; it was therefore of considerable interest to reproduce, using one line only, the whole regimen of the underground seepage flow so as to be able to calculate the upward pressure acting on the proposed floor extensions, as well as the effect of the additional rows of sheet pilings upon the old foundation.

As seen from Figs. 16 to 18, the circle method supplied a very simple and obvious solution to the problem. First, the entire space between the experimental stream-line and the solid floor was considered as a single element and a chain of circles was drawn accordingly (see Fig. 16). The sections so obtained were then subdivided by means of a system of new, smaller circles, which gave a larger number of equipotentials, and, therefore, a more precise result (see Fig. 17). A second subdivision (Fig. 18) resulted in a still greater precision, which was considered sufficient for the purposes of preparing a gradient diagram (Fig. 19).

Distances measured along the line of creep (contact line between the solid elements of the floor and the granular foundation) to the meeting points with the corresponding equipotentials, were plotted in this diagram as abscissæ, against the heads, represented by the equipotentials, as ordinates. Deleting the vertical portions of the creep, the final uplift diagram reproduced in Fig. 20 was obtained.

This showed that the two extreme rows of the proposed new sheet pilings had a considerably greater effect on the seepage-flow regimen, than any of the intermediate cut-offs, and that the weight of the contemplated floor extensions was fully adequate to balance the corresponding uplift.

An experiment which might have been completely unsuccessful was thus converted into useful, pertinent information. It should be understood, in this connection, that, had the lines of creep been drawn free-hand, viz., according to Forchheimer's old method, the influence of the personal element would have been so strong as to render the significance of the final result problematic. The point therefore was, that the seven circles representing the first stage of the new method were practically independent of the will or subconscious feeling of the designer. The slight adjustments that might have been subsequently introduced one way or the other in this diagram would have been of so minute a nature as to leave the result practically unaltered.

This, however, was not the only reason for selecting this example for instructive quotation; what indeed was believed to be more important was the fact that the process of stream-line computation was in this

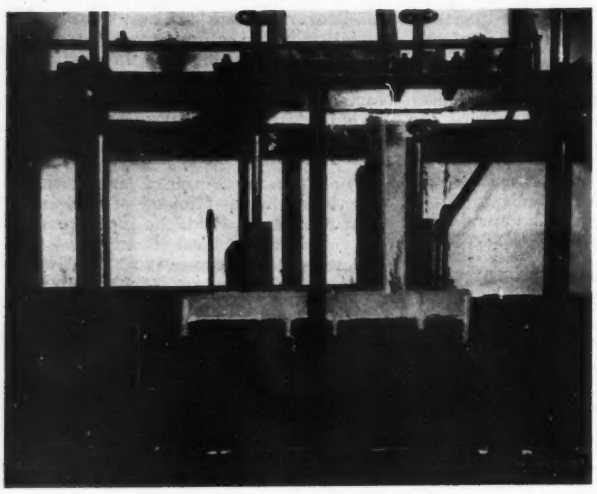


FIG. 15

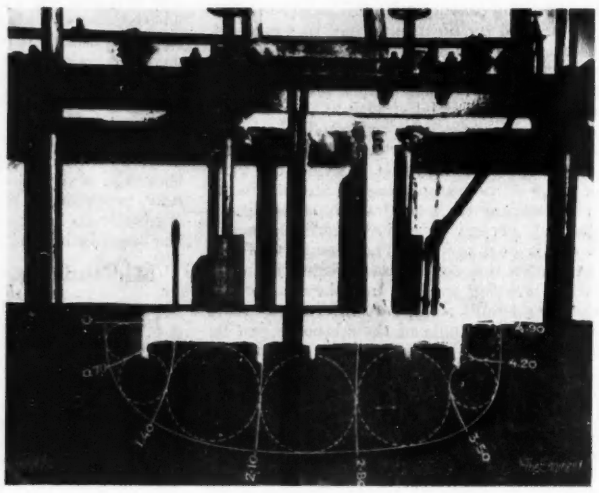


FIG. 16

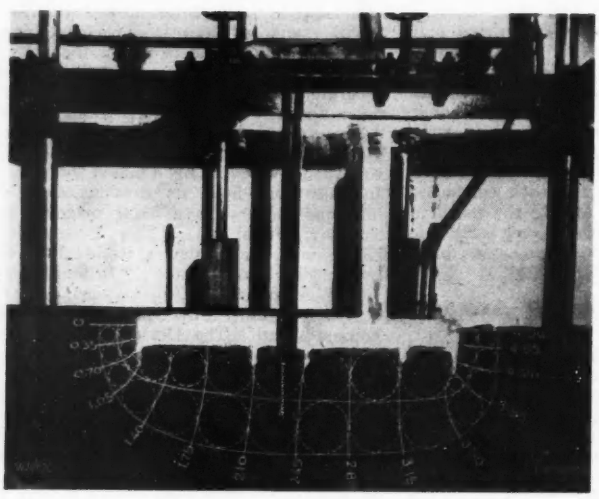


FIG. 17

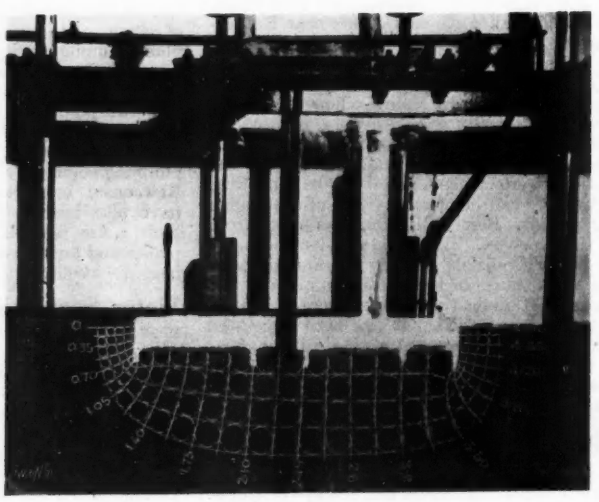


FIG. 18

* Director, Designing Service, Reservoirs and Nile Barrages, Ministry of Public Works, Cairo, Egypt.

case reversed, from the inductive as it had been in Forchheimer's method, to the deductive; i.e., instead of beginning with the detail to finish with the general, as was done by Forchheimer, this example exhibits a procedure in which the general precedes and controls the detail.

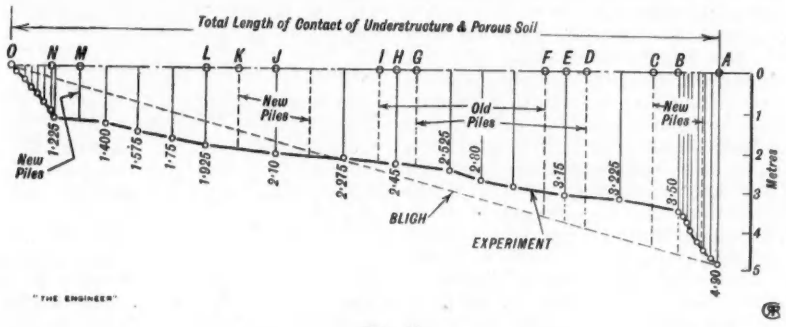


FIG. 19

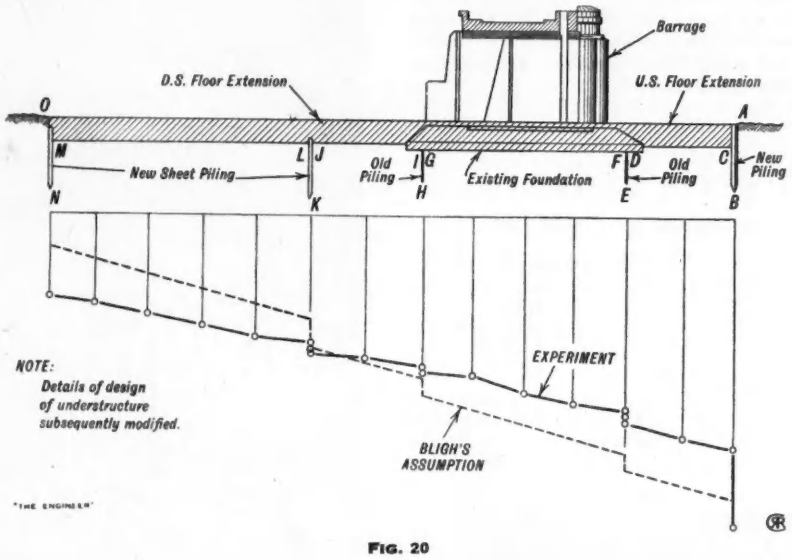


FIG. 20

Application to Elementary Fluid Mechanics

It is possibly a significant point of up-to-date tendencies in teaching hydraulics that the concept of the flow-net is presented in the opening chapters of college textbooks. In this connection particular attention is called to Professor H. Rose's course of elementary fluid mechanics,‖ which is in many ways as interesting and instructive as his earlier more advanced publication on the subject.¶

Addressing himself to the beginner, Professor Rose says: "Stream-lines are first sketched in by eye, followed by normal lines, the test of accuracy in sketching being the criterion that the two systems of lines not only must meet at right angles at every intersection, but also must be equally spaced in every zone." He further continues: "The beginner may have to make considerable use of the eraser before producing a satisfactory net . . ." and so forth.

It is here suggested that the computation can be facilitated, and the number of trials reduced, by the use of the circle method, which will help to systematise the successive approximations.

To prove the point, three diagrams (Figs. 12, 15 and 48 from Professor Rose's book) are reproduced below, and circles are inserted by the writer in the meshes of Professor Rose's networks.

Figs. 21 and 22 refer respectively to a case of "boundary transition" and a "two-dimensional rounded inlet." In both cases, it will be seen, the circles fit the mesh-work remarkably well.

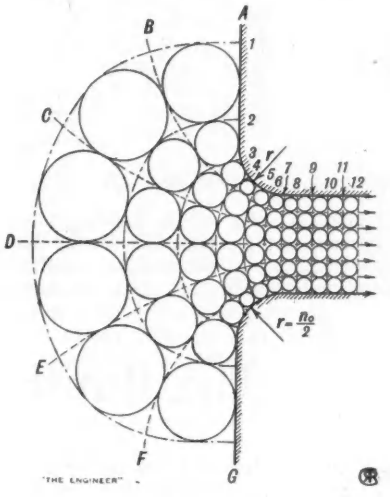


FIG. 22

A still more significant instance is shown in Fig. 23.

The flow-nets in the preceding two cases were more or less regular patterns, but in Fig. 23, which represents a "gravity discharge under a sluice gate," the local intensities of flow vary considerably from point to point of the field. The lines of flow are therefore irregularly spaced throughout the diagram, in spite of which the circles coincide surprisingly well with the stream-lines and equipotentials.

One might almost be tempted to say that the author of the original diagram had a subconscious feeling of the circle when he drew his network. Should this be indeed the case, it would mean that the circle method was not only an artificial device intended for facilitating the work of the draughtsman, but could also be visualised as the expression

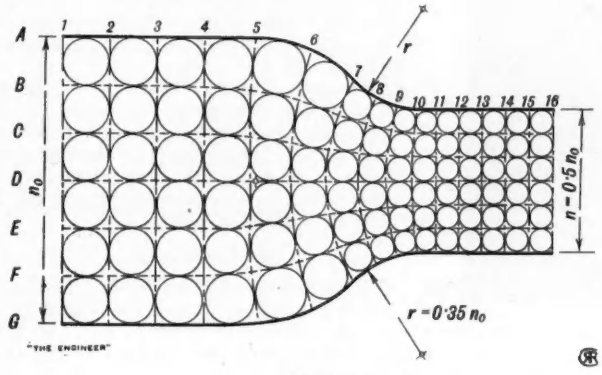


FIG. 21

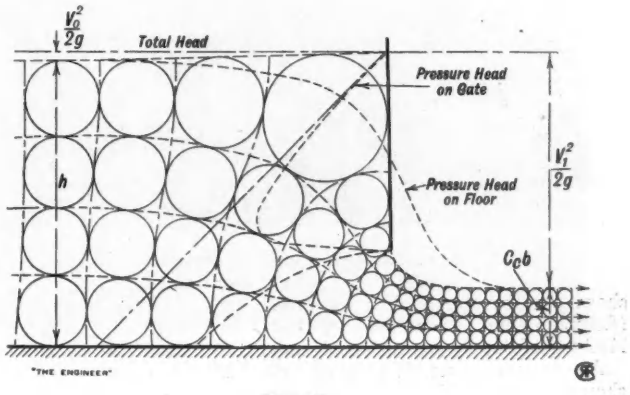


FIG. 23

‖ "Elementary Mechanics of Fluids," by Hunter Rose, New York and London, 1946.

¶ "Fluid Mechanics for Hydraulic Engineers," by H. Rose, Engineering Societies Monograph, 1938.

of a natural concept correlated with the idea of the potential.

The Circle Principle Visualised as a Criterion

In all the instances, so far mentioned, the circle principle was used for computation

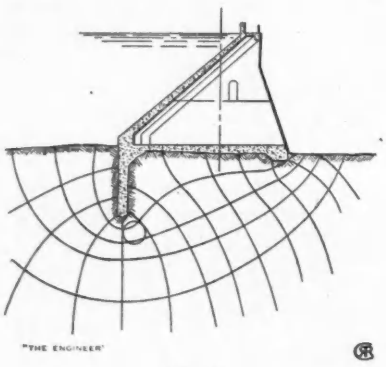


Fig. 24

purposes, in order to help drawing flow-net diagrams. In practical life it may be of some advantage to possess, also, an obvious criterion by means of which an already computed diagram might readily be verified.

Attention is called to the fact that the circle method is capable of being applied for this second objective, as well as for the drawing of the diagram.

To give an instance a diagram has been selected (see Fig. 24) which is also due to a well-known authority. The following remarks are not intended as an adverse criticism, for the drawing as it stands is perfectly well suited to its objective as an illustration of a certain principle. It is nevertheless suggested that the flow-net diagram, as such, might be subject to certain improvements.

In fact, using the circle method for verifying the computation, it can easily be shown that close to the lower edge of the piling the stream-lines are not ideal, for no circle can be inserted into the meshes of the network at this point. This is clearly seen in Fig. 24, where a circle has been superposed by the writer over the original stream-lines.

It could be argued that the ratio of width to height of a mesh need not be necessarily one to one. In fact, a diagram with any constant ratio, such as two to one, or two to three, could be computed, but then the same ratio should be applicable to all the meshes in the drawing, whereas in the case considered this ratio obviously varied.

The British Industries Fair

No. IV—(*Continued from page 468, May 14th*)

WE conclude below our description of some of the more novel and interesting exhibits at Castle Bromwich, Birmingham.

Centrax Power Units, Ltd.

An unexpected exhibit at Castle Bromwich, which created much interest, was a small gas turbine engine designed and built by Centrax Power Units, of Brentford, Middlesex, and shown on the stand taken by Power Jets (Research and Development), Ltd., the Ministry of Supply gas turbine agency.

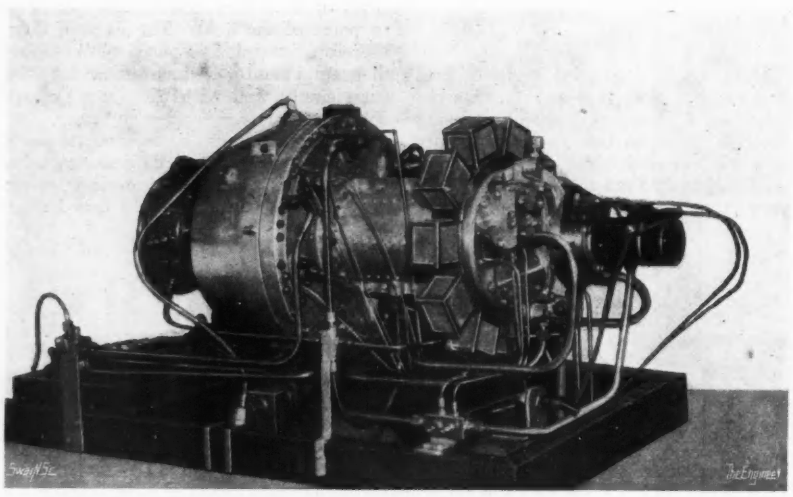


Fig. 23—160 B.H.P. Gas Turbine Engine—Centrax

An accompanying illustration, Fig. 23, shows the unit at the Fair. We understand that it has been primarily designed for road transport application, to develop 160 b.h.p. at full power. As shown it comprised the compressor and combustion chamber portions of the engine, the separate turbine unit, which is directly coupled to the vehicle transmission, not being displayed. One of the smallest gas turbine engines yet built, its overall length from starter motor to reduction gearbox is given as 5ft, and its maximum diameter 17in. Its weight is said to be 250 lb.

As already mentioned, the compressor and turbine rotors are not mechanically coupled. At maximum power the compressor rotor is designed to revolve at 43,000 r.p.m., and the turbine rotor at 35,000 r.p.m. Fuel consumption (paraffin or diesel oil) is calculated to be 0·7 lb/b.h.p./hr. The overall pressure ratio is 5·8 to 1, and air mass flow 2·1 lb per second, with a maximum gas temperature of 1100 deg. Cent. absolute. Compression of air takes place in eight axial stages and one centrifugal stage. There are seven combustion chambers, interconnected so that, when starting, flame is propagated from two igniter plugs.

This interesting exhibit was designed by Messrs. R. H. H. Bar, G. White and H. Leach, all of whom were once with Power Jets, but are now with Centrax Power Units, Ltd., a company formed in 1946 to design and build small gas turbines.

Kodak, Ltd.

Among the lighting units shown by Kodak, Ltd., Kingsway, London, W.C.2, was a spotlight intended for industrial use and designed to give a powerful beam from a 2000W lamp, with the minimum of heat radiation.

The photograph reproduced in Fig. 24 gives a general view of the equipment, showing the adjustments whereby the lamphouse can be tilted about a horizontal axis or raised on its stand to any position between 4ft 8in and 6ft 11in above floor level. A length of 25ft of twin flexible cable is provided. A 7½in diameter anodised, spun aluminium

Fig. 24—Industrial Spotlight—Kodak

spheroidal reflector is mounted behind the lamp. The whole assembly is enclosed in a double-skinned aluminium lamphouse, which can be handled comfortably even after the lamp has been operating for some time. The front door of the lamphouse accommodates a 10in diameter, 5¾in focus "Fresnel" type lens.

Focusing can be carried out from the front or the rear of the lamphouse and the beam can be varied from "full flood" to "full spot." It is claimed that the lamphouse remains silent as the lamp warms up or cools down, so that the equipment can be used for sound film work.

E. K. Cole, Ltd.

A comprehensive range of fluorescent lamps and fittings formed the central group of exhibits displayed by E. K. Cole, Ltd., Southend-on-Sea, Essex. Among the fittings we noticed a series capacitor ballast which has been specially designed to ensure better and more consistent fluorescent lamp operation under conditions of fluctuating mains voltage.

Discharge lamp circuits are particularly affected by mains pressure variations, which

may be of the order of 15 per cent of the declared pressure. Because discharge lamps have a negative resistance characteristic, the decreased current resulting from a fall in mains voltage produces an increased potential across the lamp, causing glow-type starter switches to reignite and thermal starter switches to suffer a drop in filament temperature. In both cases the bimetallic elements close, causing the lamps to flicker.

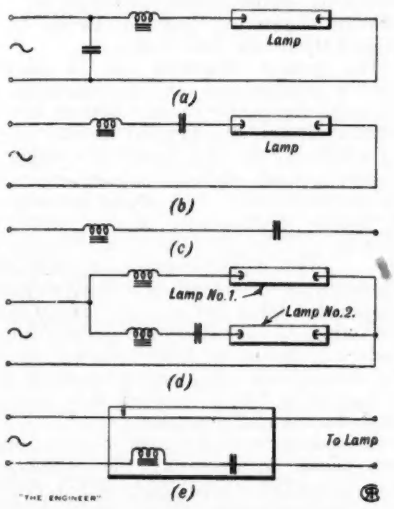


FIG. 25—INDUCTIVE AND SERIES CAPACITOR BALLASTS—COLE

Furthermore, if the mains voltage falls below a certain level, discharge lamps may fail to strike.

Irrespective of mains fluctuations, however, fluorescent lamps, with their negative resistance characteristics, require an impedance in the circuit, and this impedance usually takes the form of an iron-cored choke with an air gap. With this arrangement, regarding the discharge as an ohmic resistor, the influence of the added inductive reactance would cause the circuit to have a very poor power factor. To improve the

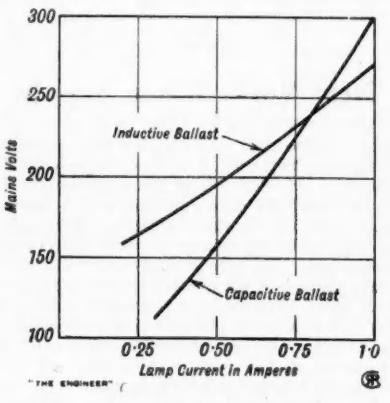


FIG. 26—BALLAST CHARACTERISTICS—COLE

power factor, it is usual to incorporate in the circuit a paper dielectric condenser, as at (*a*) Fig. 25.

Another form of discharge lamp control takes the form of a series capacitor ballast, as shown at (*b*). Usually this device forms half of a twin lamp circuit, as indicated at (*c*). In designing this form of ballast it is usual to choose a capacitive reactance and tune it with an inductive reactance to resonate at a suitable frequency. Thus a series capacitor ballast controlling an 80-W fluorescent lamp has a 7·5μF condenser, which is tuned by an air-cored choke to a frequency usually of 90 c/s, as indicated at (*d*).

Series capacitor and inductive ballasts have a different volt-ampere characteristic and the comparison given in Fig. 26 indicates that the curve of the capacitive ballast is much steeper and straighter than that of the inductive ballast. This difference suggests that the capacitive ballast will be much less affected by mains fluctuation than the normal inductive ballast.

Accordingly, an Ekco-Ensign series capacitor ballast for 80-W fluorescent lamp operation has been produced particularly for use in situations where mains fluctuations would otherwise cause inconvenience by flickering or reduced light output. This ballast unit consists of a choke and capacitor built into a robust mild steel case and sealed by bituminous compound. The circuit is as shown at (*e*) Fig. 25.

These series capacitor ballasts are made in three forms, suitable for the following voltage ranges: 200V–210V, 220V–230V, and 240V–250V. Each unit weighs 6½ lb and the physical dimensions are the same as those of the standard Ekco-Ensign 80-W, high-power-factor ballasts. As an indication of the performance it is stated that the 220V–230V unit will start and operate an 80-W fluorescent lamp at voltages as low as 160V. The rated power losses as specified at 80W and the circuit power factor is normally 0·67 leading.

CROMPTON PARKINSON, LTD.

Two new fluorescent lighting fittings, designed to combine pleasing appearance and comfortable vision with high efficiency and easy maintenance, were shown by Crompton Parkinson, Ltd., Astor House, Aldwych, London, W.C.2.

The first of these, which is known as the "Aldwych," is a ceiling fitting designed for use with two 80-W fluorescent tubes. Side panels of fluted "Perspex" diffuse outwards the light from these tubes, while a lattice-louvred base conceals the lamps from normal view but allows ample downward light. The side panels and louvres are easily removed for cleaning; the louvres swing down from either side on "jiffy-lock" hinges. All outside metal work is enamelled to a satin aluminium finish, and all internal reflecting surfaces are enamelled white. The control gear is contained within the body of the fitting, the lamps and starting switches being readily accessible.

The "Holborn" fitting is a ceiling fitting, for use with four 40-W fluorescent tubes. Panelled sides and a base of fluted diffusing glass provide well dispersed illumination, while a portion of the total light is directed upwards over the ceiling. To simplify erection, the "Holborn" and "Aldwych" fittings are arranged to glide over specially designed runners, which are included in the ceiling fixings.

Similar fittings, but in the form of pendants suspended from a ceiling plate, are available. With this single difference, the "Howard" fitting is a counterpart of the "Holborn," and the "Albany" is a counterpart of the "Aldwych."

MARSHALL RICHARDS MACHINE COMPANY, LTD.

An interesting machine shown by the Marshall Richards Machine Company, Ltd., of Crook, Co. Durham, was a horizontal bull block, fitted with a 36in diameter block. This company forms part of the Marshall, Sons and Co. group, and specialises in wire-drawing machinery; the bull block, for drawing tubes and sections, is representative of its products.

Accompanying illustrations, Figs. 27–29, show the 36in block and its control gear. The firm makes horizontal bull blocks in two sizes, the large machine shown, of which the block has a working length of 32in, and a small machine fitted with an 18in or 20in diameter block, with 18in working length. They are designed for a maximum pull of 8500 lb, and are normally fitted with variable-speed d.c. motors, giving a range of drawing speeds from 100ft per minute to 300ft per minute.

The machine can be supplied with pulling-in arrangements especially designed for drawing sections in a flat spiral or for drawing tubes or sections which can be traversed along the block. For drawing in flat spirals

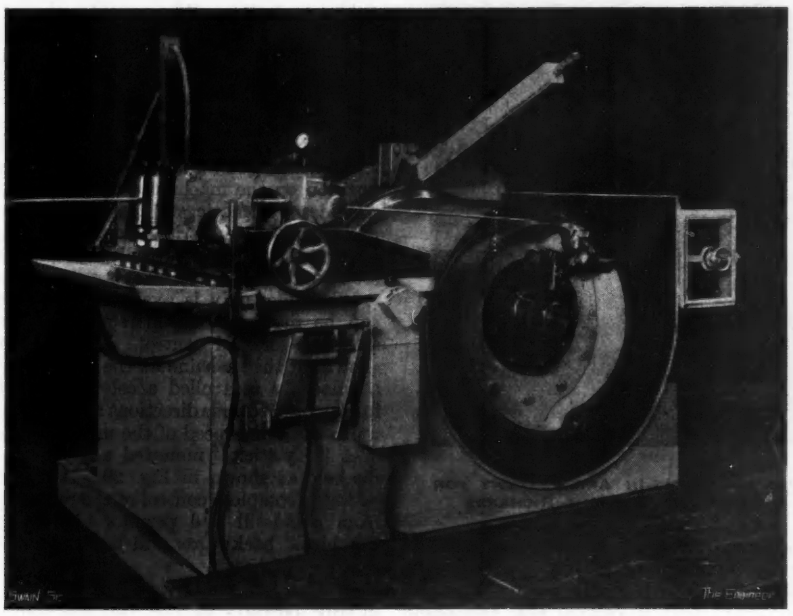


FIG. 27—36-IN HORIZONTAL BULL BLOCK—RICHARDS

a special type of disappearing dog is fitted. This dog disappears into a recess inside the block, which is closed by a hinged flap, thus forming a continuous periphery upon which the strip can be coiled without having to pass over any recess likely to form kinks or flats in the strip. For drawing tubes and sections which can be coiled in a continuous spiral along the block, a pulling-in dog of more normal design is supplied; this fits in a specially shaped contour on the end of the block as shown in Fig. 28. Either type of pulling-in arrangement can be fitted to the large or small machine, as required.

The die holder is carried on a slide of heavy section and is arranged to be traversed by hand or by power, in a line parallel to the axis of the block, the power traverse being engaged by a lever at the left-hand side of the machine. The machine stops automatically when the die box reaches the end of its travel in either direction. A quick-release lead screw nut is fitted which enables the die box to be quickly returned to its starting position without using the lead screw.

A range of change gears is provided, giving pitches to cover the range of sizes in tubes or sections which are to be drawn. The change wheels are driven like those on an ordinary lathe and a change from one traverse to another can be made in a few moments. They are mounted on the rear of the machine and enclosed by a detachable casing.

The die holder can be supplied to accommodate standard tungsten carbide dies or steel dies of circular section. Alternatively,

FIG. 28—PULLING-IN ARRANGEMENT FOR TUBES AND SECTIONS—RICHARDS

it will accommodate a range of bolsters carrying built-up, or matrix type dies for section drawing. The die box is arranged to swivel in both a vertical and horizontal plane so that the die can align itself accurately with the pulling-in dog to prevent kinking of the tube or strip when pulling in. It also provides for automatic aligning of the die when drawing strip in a flat spiral, in which case the effective diameter of the spiral gradually increases as the drawing proceeds. Suitable guide rollers of large diameter are mounted in front of the die box to ensure that the tubes or sections enter the die in a reasonably straight line.

The machines are normally fitted with an electrically driven pump and suitable piping to provide a continuous flow of lubricant round a tube and on both the top and bottom surfaces of a strip as it passes into the die. If required, a thermostatically controlled

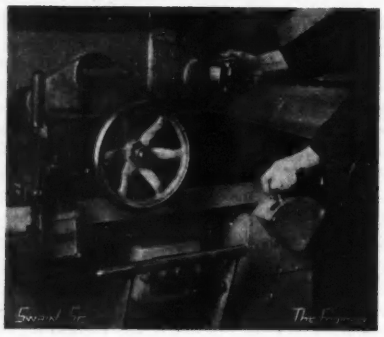


FIG. 29—BULL BLOCK CONTROLS—RICHARDS

electric heater can be fitted to permit the use of high-viscosity oils. A self-contained liquor tank is built into the machine and a suitable tray is fitted round the traversing slide and die box to prevent escape of drawing liquor.

The block is not mounted directly on its driving shaft; it is carried on a strong stationary steel column. This construction permits the maximum drawing load to be carried on the end of the block without imposing any bending load on its driving shaft. The block runs on large ball or roller bearings with suitable provision for lubrication. It is driven from the motor through a worm gear running in oil. The motor is directly coupled to the worm shaft through a flexible coupling.

These machines are arranged to be driven by variable-speed d.c. motors, usually with a speed range of 3 to 1, controlled by shunt field regulation. When a d.c. supply is available, operation is by contactor gear mounted in a separate sheet steel cubicle, the machine being controlled by push buttons giving "inch forward," "inch reverse," "run" and "stop" positions, with provision for setting or varying the final speed by a shunt field regulator mounted in an accessible position on the machine. Dynamic braking provides automatic stopping when the end of the drawn material comes through the die or when the stop button or the emergency stop handrail is operated.

When a.c. only is available the machine can be fitted with a mercury arc rectifier arranged for grid control. This system, as shown on the machine at the Fair, provides a smoothly controlled acceleration in both forward and reverse directions and for running up to the basic speed of the motor by means of a "joy-stick" mounted adjacent to the die box, as shown in Fig. 29. It gives the operator complete control of the motor speed from standstill and permits him to creep the block backwards and forwards at any speed he wishes.

In addition, the "joy-stick" can be set in any position to run the machine continuously at speeds between zero and the basic speed of the motor. For controlling the normal speed range of the motor, which is usually from 400 to 1200 r.p.m., a shunt field regulator is provided similar to the one used on the push button-controlled equipment. The rectifier and other necessary control gear is fitted in a sheet steel cubicle and is complete, ready for direct coupling to the a.c. supply.

On either type of electrical equipment the variable-speed d.c. motor develops constant torque from zero to its basic speed and constant horsepower over the speed range of 3 to 1 controlled by the shunt field rheostat.

FERGUSON, PAILIN, LTD.

Examples of high and low tension switchgear, and various detail components such as control switches, small wiring fuses and indicating lamps, were included in the exhibits shown by Ferguson, Pailin, Ltd., Higher Openshaw, Manchester.

The greatly increased use of spring-closing mechanisms, as recommended in B.S. 116 for power-closing devices above certain ratings, was typified on this stand by a full-scale working model of a standard B.R.P. 5, 11-kV oil circuit breaker, operated by a motor wound spring closing mechanism. A special characteristic of this design is that the final shock to the circuit breaker at the end of the closing stroke is limited by the ingenious use of a flywheel device, whereby the breaker takes just as much energy from the springs as is necessary to close fully home under any circuit condition from no load to full short circuit. Any surplus energy in the springs is used to recompress them partly, ready for the next operation.

A modern type of remote control panel was shown incorporating the company's well-known flicker-type control switch, whereby positive indication of the circuit operating condition is obtained by a single lamp mounted in the body of the control switch. The control switch itself is physically situated in a line diagram placed at a convenient height so that the operator can readily appreciate the circuit conditions while carrying out switching operations.

ERRATUM.—In describing the exhibits of Prior Stokers, Ltd., we wrote in our issue of May 7th, page 442, that the standard stokers are made in four sizes rated from 240,000 B.Th.U. per hour to 600,000 B.Th.U. per hour. The makers inform us that the rating is actually from 150,000 B.Th.U. per hour to 8,000,000 B.Th.U. per hour, comprising fifteen models.

New York Water Supply

THE New York City water supply system cannot furnish sufficient water to meet present-day demands, if an extended dry season should occur. The present consumption for the city and suburbs is about one and a quarter billion gallons per day, while the dependable safe yield from all sources is about 250,000,000 gallons less. An extended drought, therefore, would so deplete the present reservoir capacity as to place the city in a precarious situation. The first several stages of the development of the Delaware River reservoir system will be completed in the early 1950's and will add about 500,000,000 gallons per day to the city supply. Investigations and studies are being made for additional sources of water supply to meet the future requirements of the city. Over 80 per cent of the present water yield is from surface sources, the remainder coming from ground water sources of city and private water company wells in Long Island. Of the more than 700,000 water service connections in the city for buildings and uses of all kinds, less than 200,000 are metered. Under such a system most plumbing leaks go unattended and the loss of water is quite extensive. It has been recommended that all service connections be metered, so as to reduce the waste of water to a minimum. It is estimated that under present conditions it would require from five to ten years to install such meters.

The Iron and Steel Institute

No. II—(*Continued from page 478, May 14th*)

ON Wednesday morning, May 5th, a joint discussion took place on the following papers :—

CONSTRUCTION AND REPAIR OF OPEN-HEARTH FURNACES

By D. C. Muir

Synopsis

An account is given of the furnace repair programme at the works of the Consett Iron Company, Ltd., over a period of seven years, and of a system of balanced repairs which enabled nine out of ten furnaces to be in production at any one time. Data regarding the construction, life, replacement and costs of refractories in various parts of the furnaces are included, and proposals regarding the introduction of the all-basic furnace, furnace insulation, and the conversion of the furnaces from producer gas to creosote pitch, coke-oven gas, or creosote-pitch/coke-oven-gas firing are discussed.

THE DESIGN OF OPEN-HEARTH GAS PORTS

By M. P. Newby, B.Sc., A.Inst.P.

Synopsis

Experiments were carried out on a model of the gas port of a producer-gas-fired open-hearth furnace with the object of determining the efficiency of a port considered as an arrangement for converting pressure energy into kinetic energy of gas motion ; the resistance of the port to the outgoing products of combustion was also measured. The experiments showed that the designs tested have fairly high efficiency and that changes in design can bring only a limited improvement. Funnels added to the port between throat and furnace chamber gave considerable reduction of outgoing resistance, but involve practical difficulties which make them of limited industrial value, and it is concluded that the only way to increase the gas velocity substantially is to increase the pressure behind the port.

INSTALLATION AND USE OF INSTRUMENTS ON OPEN-HEARTH MELTING FURNACES

By R. C. Baker, A.Met., A.I.M.

Synopsis

The installation and development of recording and control instruments for routine use in a small open-hearth plant are described. Features of the system are the recording of the furnace roof temperature and the gas and air flows on one chart, also an experimental automatic crown temperature control. The instruments have proved of great value to the operators and have increased the melting rates.

Mr. Muir said that since writing his paper the steel industry of this country had accepted the continuous working week, and therefore the week-end shut down, one of the objections to the all-basic furnace, had been removed. His firm had arranged to build one of the 150-ton fixed furnaces in a fully suspended construction with chemically bonded, chrome-magnesite bricks. The furnace would have a single slag pocket and an unrestricted uptake. There was no doubt they would have their difficulties with the all-basic construction, but he was sure they would be overcome.

Discussion

Dr. J. H. Chesters (United Steel Companies) said that an All-Basic Furnace Sub-Committee had been working actively for about a year and had produced preliminary recommendations intended to help those who wished to get started and did not know where to begin. The main trouble at the moment was that there were no proper records of furnaces which had already run their lives. Whilst there might be data of one successful furnace there was not available corresponding data for other furnaces. Therefore, one of the first tasks of the Sub-Committee, which was about complete, was to formulate one more questionnaire in which people who had built furnaces were asked to give the information. It was also being arranged for a good deal of work to be done on the fundamental properties of refractories, notably the creep properties at high temperatures, which it was thought was essential if more than an empirical approach to the matter was to be made. At least three firms had placed orders for all-basic furnaces and probably by the end of the year there would be half a dozen. The basic insulating brick so far had had practically no application, but it was felt that ultimately it would have a very real application. The cost of the job, which was five or six times that of silica, was largely determined by the enormous cost of the raw material.

Commenting on the paper by Mr. Baker, he said the introduction of automatic control should not frighten anyone. Mr. Baker had not stated that as far as was known this was the first gas-fired furnace on which the gas flow had been linked to the roof temperature, and Mr. Baker was to be very much congratulated on achieving that. It was a much more difficult problem than linking roof temperature with oil flow.

Mr. F. L. Robertson (Messrs. John Summers and Sons) said the introduction of instruments had brought two new shop difficulties in their train. In the first place, how could a melter use all the measurements that had been found to be quite clearly necessary for the economic and technological good of the steel and the furnace ? There were just too many to attend to. Secondly, how could the co-ordination of these measurements be planned and ordered before the charge and, equally important, inspected after the charge ? Mr. Baker had met these difficulties by introducing automatic gear, and by starting multiple-chart readings. In both, he had not waited for the last word in engineering skill and invention, but had started straight in with the bits and pieces he found lying round the works, which was a most commendable start. And how quickly this kind of start led the way ! The automatic furnace no longer needed preaching about ; it was well on its way. Mr. Baker's other point, however, was in its infancy, and he would like his opinion on extending his multiple chart along the lines shown in a chart which he himself had prepared. This chart consisted of (1) roof temperature record, (2) oil record, (3) steam record, (4) air record, (5) CO_2 record, (6) O_2 record, (7) roof pressure record, (8) charging record, (9) spar lime and ore feeds, (10) time feeding ore is allowed to commence, (11) immersion temperature of charge, (12) temperature ordered to correspond in the carbon content, (13) carbon drop, (14) sulphur drop, (15) slag analysis at commence feeding point and at tap.

All these fifteen entries were inter-related and instructions about their inter-relation were given before the chart starts. It was therefore necessary for manager and melter to see clearly and early whether the orders had been carried out or what stood in the way of their execution. It was proposed that all these entries would be made on the chart mechanically as they happened, or as they were reported, and antetimed to the sampling time. He added that his firm was discussing with B.I.S.R.A. the possibility of putting this into practice and hoped to have a first approximation to this supplied by an instrument firm next year.

Dr. A. H. Leckie (British Iron and Steel Research Association) said that Mr. Baker was in an exceptional position in that both he and his father had made a hobby of instrument building and designing so that in his ability to make a complete set of instruments from odds and ends at very low cost he was not setting an example which could be followed by all. There were complete and enviable instrument installations in new and relatively high tonnage shops, but Mr. Baker had shown that it was just as feasible and just as important to install instruments in older and smaller shops making more specialised steels. The word " instruments " did not invariably mean the expenditure of thousands of pounds on glass-encased panels and concealed lighting, desirable as these things might be in new tonnage plants.

Referring to Mr. Newby's paper, he said this work was undertaken at the request of the Steel Making Division of B.I.S.R.A., because of the lack of data on friction factors in bends similar to those found in open-hearth furnace uptakes and ports. Mr. Newby had now given figures based on reliable and careful experiments, but the paper did not appear to be sufficiently clear in explaining to what the F and K factors really referred. The configuration used in the experiments should give two factors : one appropriate to the combined bend and change of section between the uptake and the port throat, and one for the exit from the port to the furnace chamber. The latter could be regarded as unity if the furnace chamber was very large, but he did not think it was sufficiently large relative to the port area in Mr. Newby's model. Determination of these two friction factors, therefore, demanded three static pressure measurements—one in the uptake, one in the port throat, and one in the " furnace." Although he believed Mr. Newby had determined the pressure at all three places, this was not stated specifically, and one was left with the impression that only the total pressure drop between uptake and furnace was studied, apart from some special measurements. The object of all this work was to obtain the high gas velocity necessary to get a short hot flame with the conventional port design without excessive gas pressure in the ingoing system. It was now known, however, that it was possible to get a short flame without unduly high gas velocity by using other kinds of port such as the modified Maerz, which they had been trying at Shelton, and it should therefore be possible to get a short flame with relatively low gas pressure in this way.

Finally, referring to Mr. Muir's paper, he said one could not help being impressed by the immense amount of brickwork still used round the ports of many furnaces to-day, and by the fact that the chequer stoppage was still a frequent cause of a furnace coming off. He was convinced, as the result of recent B.I.S.R.A. experiments, that funaces could be built to operate well with far less brickwork than was commonly used.

Dr. D. F. Marshall (Park Gate Iron and Steel Company) said that anyone connected with an open-hearth furnace shop would have experienced at some time or other the temptation to keep an old furnace working one or two weeks longer. They would also undoubtedly have experienced the all-too-frequent unfortunate consequences of this course of action—a roof fallen in on a charge, or two or more furnaces off for repair at the same time with insufficient labour available to tackle them simultaneously. In most cases, production over a period would be lost, and not gained, as originally hoped. The only satisfactory method of approach to this problem, as Mr. Muir had indicated, was a planned repair programme. This immediately implied an ability to forecast the lives of the individual parts of the roof furnace. Mr. Muir had obviously given a great deal of thought to the study of furnace records, to the types of refractories used in furnace construction, and to the speeding up of repairs, all with the view of increasing furnace availability. There was, however, another fundamental factor which had not been mentioned, viz., instrumentation accompanied by strict furnace control, either manual or automatic. If in each open-hearth shop the question of instrumentation was tackled intensively from two angles, viz., instruments and instrument support organisation, it would become practicable, as had been experienced on his plant, to practice a standard furnace control which furnacemen and staff could appreciate and follow. One advantage of this type of technique was that the range of roof life or chequer life for a given furnace became much narrower, and life forecasts and repair planning were greatly helped.

The authors replied shortly to the discussion.

On Wednesday afternoon, May 5th, there were

two joint discussions, the first being on the following :—

THE PRODUCTION OF NODULAR GRAPHITE STRUCTURES IN CAST IRON

By H. Morrogh and W. J. Williams, B.Sc.

Synopsis

A study has been made of the production of nodular structures in nickel-iron-carbon alloys, and it was found that additions of cerium to the molten alloys gave, on solidification, nodular structures in hyper-eutectic alloys even with very low nickel contents. The microstructures of such cerium-treated alloys have been described in detail. When the alloys contained appreciable amounts of sulphur, no nodular structures were obtained.

Attempts to produce nodular structures, by adding cerium to low sulphur hypo-eutectic cast irons, were only partially successful, but when hyper-eutectic irons were treated, structures consisting of hyper-eutectic spherulites and quasi-flake graphite were obtained. With increasing amounts of cerium in such irons the mechanical properties show a progressive improvement. Examples are given of the influences of cerium in hyper-eutectic unalloyed irons and in austenitic irons. The influence of sulphur upon the cerium treatment is discussed and the general composition requirements for the production of nodular structures in the as-cast state are dealt with.

Cerium is a desulphuriser and a powerful carbide stabiliser, and one of its functions in producing nodular graphite structures is to reduce the sulphur content of the iron to a relatively low value. The mechanism of solidification of these irons is dealt with, and the hyper-eutectic graphite is shown to form in the liquid, with a spherulitic structure. The quasi-flake graphite forms by the decomposition of a white iron eutectic after solidification. In the vicinity of the hyper-eutectic spherulites the eutectic graphite is deposited upon the already existing nodules.

When the number of hyper-eutectic nodules is increased artificially no quasi-flake graphite forms. A process for accomplishing this has been developed involving the addition of a graphitising inoculant after the cerium addition. This treatment gives irons having the whole of the graphite in the nodular form. The mechanical properties of such irons are very good and several examples are given to illustrate this.

The cerium may be added to cast iron in the form of *mischmetall* and the treatment must be applied to the molten metal shortly before casting. Cerium is lost on remelting and a reversion to normal flake graphite structures occurs.

Grey cast irons containing nodular structures in the as-cast state are referred to as "nodular cast irons." Previously the only method available for producing such structures was by the lengthy annealing of white cast iron.

THE CARBIDES IN IRON-CARBON-SILICON ALLOYS AND CAST IRONS

By D. Marles

Synopsis

A metallographic study has been made of the carbides occurring in cast irons and iron-carbon-silicon alloys with silicon contents up to 7 per cent and carbon contents of 1·7 to 3·6 per cent. It has been found that with silicon contents in excess of about 2·5 per cent, a carbide phase appears which does not respond to heat tinting in the same way as normal cementite. With increase in silicon up to 7 per cent this phase increases in amount, whilst the normal cementite phase decreases until at 7 per cent the carbide phase consists entirely of the constituent not responsive to heat tinting. It is suggested that this carbide phase is a silico-carbide and that it has a lower stability at elevated temperature than normal cementite.

Discussion

Dr. L. B. Pfeil (Mond Nickel Company, Ltd.), who spoke only on the first paper, said it represented an important advance in knowledge towards the target for which many had striven in recent years, viz., the commercial production of cast irons which, in the as-cast condition, would have a nodular graphite structure. From this paper, and what had been done elsewhere, it seemed that engineers could quite reasonably anticipate having in the near future what really amounted to a new alloy at their disposal and this new structure should play an important part in engineering construction in the future. It was necessary to bear in mind, however, that there was a big task before the metallurgist not only to work out the details of the fundamental effects of this treatment on graphite formation in cast iron, but also to convert the findings of laboratory and pilot scale experiment into full and effective economic production.

Mr. W. S. Owen (Liverpool University) felt that any discussion of the carbide phases in cast iron was bound to be inconclusive, as our present knowledge of the stable and metastable iron-carbon-silicon systems was based upon inadequate experimental data, particularly in the peritecto-eutectic and higher silicon regions. Before really satisfactory interpretation of structures such as were described in this paper could be made, extensive thermal analysis of high purity alloys coupled with an X-ray investigation of the phases occurring in the solid was necessary. His colleagues and himself were already working along those lines and hoped to contribute some of the data required.

Mr. M. Hallett (Sheepbridge Stokes Centrifugal Castings, Ltd.) said that on the practical side all his experience confirmed the claims of the authors of the first paper. Nodular cast iron could be produced in the foundry with additional strength to at least 35 tons per square inch, but much work still remained to be done to determine the exact mechanism of the formation of nodular graphite and the temperature at which it formed. Until the process could be expressed in a quantitative manner we should not feel entirely satisfied.

Mr. K. H. Wright (British Roll Makers' Corporation) thought that whilst the results of the present researches had given industry a new material, they might be capable of a much broader interpretation in order to arrive at a complete understanding of the anomalies that we had in graphite iron. Such anomalies were, why did one iron chill more readily than another of similar composition ? Why was undercooling encountered ? Why was there coarse and fine mottle ? and so on. There was a complete lack of understanding on these various points, but there was a possible link in this nodular iron and cerium-treated iron which might explain these hitherto inexplicable points. He thought that link was sulphur, which appeared to be the important element in this nodular iron, i.e., the control of the sulphur content.

Mr. C. H. Payne (Qualcast, Ltd.) said that a difficulty in experimenting with cast iron was the ignorance of the rate of formation of carbon. There was a possibility that it was just a straightforward solution of carbon in iron. Equally, there was the possibility that it existed entirely as iron carbide dissolved in molten iron, whilst it was also quite likely that it was somewhere between the two, depending on the temperature, the rate of change of temperature, and the presence of some element which might possibly combine with carbon or have a catalytic influence on the formation or breakdown of iron carbide. All this, of course, was pure conjecture and until we had some solid experimental evidence it must remain conjecture for quite a while. The point he wished to make was that change of temperature could, in many circumstances, behave like an alloy addition to an iron-carbon alloy. That had been his experience as a works metallurgist engaged in the manufacture of hyper-eutectic cast iron, although he would not say that the phenomena were absolutely identical. Was it the fact that rapid cooling did the trick or did other factors enter into the problem, such as local undercooling, or, as suggested in the paper, the result of pressure upsetting the normal graphitisation ? There was also the possibility that inverse chill played a part because there was a tendency towards this in the manufacture of hyper-eutectic cast iron.

Mr. R. J. Brown (Nuffield Central Research Laboratories) said that the problem was to determine the mode of formation, as spherules, of the hypo-eutectic graphite. Examination of a number of castings provided absolute evidence that for a given composition mass effect played a large part in the formation of nodular graphite. With castings of varying sections it was quite usual to obtain a white crystalline fracture in the thin sections and a particularly mottled fracture in the heavier sections, although judicious adjustment of the composition of the metal might be successful in producing a white crystalline fracture throughout. Examination of the microstructure of these varying fractures showed that the white crystalline zones generally had the graphite entirely in the spherulitic form, whereas the mottled zones had the graphite in the undercooled form, with isolated patches of partially formed spherules. The interface of the white and mottled zones showed spherulitic graphite in the white zone, with partially formed spherules and undercooled graphite in the mottled zone. The castings of the heavier sections, having a fairly uniform fracture lying midway between the white and the mottled condition possessed graphite in both the spherulitic and the quasi-flake form. He suggested that for a given melt of cerium-treated cast iron there was an optimum cooling rate for the formation of spherulitic graphite, and that lower cooling rates would produce quasi-flake graphite, whereas still lower rates produced undercooled graphite. The formation of nodular graphite was undoubtedly closely related to inoculation, and it was likely that the authors' suggestion in their conclusions that cerium induced nuclei into the melt, promoting spherulitic crystallisation of the hypo-eutectic phase, was correct. A further possibility was that quasi-flake graphite was formed by deposition of the eutectic graphite on the initially formed undercooled hyper-eutectic graphite, and that normal undercooled graphite would form only at low melting rates.

Mr. Williams and Mr. Marles each made a brief reply to the discussion.

Joint discussion then took place upon the following papers :—

ABNORMAL CREEP IN CARBON STEELS

By J. Glen, B.Sc., A.R.T.C., A.I.M.

Synopsis

Short-time creep tests at a stress of 8 tons per square inch and a temperature of 450 deg. Cent., have been carried out on a series of low-carbon steels containing 0·4 to 1·5 per cent of manganese, 0·01 to 0·15 per cent of silicon, and 0 to 0·11 per cent of molybdenum, and with varying amounts of aluminium up to 3 lb per ton. It is shown that manganese, silicon and molybdenum within the limits examined reduce the creep rate and that the abnormal creep resulting from aluminium additions is reduced considerably by these elements. In production casts of basic open-hearth steel it is shown that, with proper control, aluminium may be used as a deoxidiser, provided that the steel remains coarse grained as measured by the McQuaid-Ehn test.

THE CREEP PROPERTIES OF MOLYBDENUM, CHROMIUM-MOLYBDENUM AND MOLYBDENUM-VANADIUM STEELS

By J. Glen, B.Sc., A.R.T.C., A.I.M.

Synopsis

The numerous variables to be considered in the study of creep are discussed at length, and the importance of controlling, and, where possible, of isolating these variables, is emphasised. Attention is drawn to the limitations of short-time tests, particularly when estimating the creep characteristics of a new type of steel. Creep tests at different temperatures and stresses have been carried out on 0·5 per cent molybdenum, 0·8 per cent chromium/0·5 per cent molybdenum, and 0·5 per cent molybdenum/0·25 per cent vanadium steels, and the effect of carbon, silicon, manganese and aluminium have been determined. The effects of various heat treatments have also been examined. Rupture tests of up to 58,000 hours' duration have been carried out and the mode of failure discussed. By an extensive series of long-time creep tests the stress/temperature relationships for 0·1 and 0·2 per cent deformation in 100,000 hours have been estimated for the molybdenum-vanadium steel and suitable short-time tests for checking the quality of such steels are discussed. The results show that the molybdenum-vanadium steel in the normalised and tempered condition has creep and rupture properties much superior to those of the molybdenum and chromium-molybdenum steels.

Discussion

Mr. W. E. Bardgett (United Steel Companies), commenting on the first paper, said he had carried out a series of short-time tests on high-silicon steel, which indicated that the phosphorus content had quite an appreciable effect on the creep resistance, increasing phosphorus being distinctly beneficial. Although these tests were short-time tests, the results were fairly definite.

The author of the second paper referred to

the superiority of open-hearth over electric steel, but in the speaker's view whether it was superior to electric steel or not depended on the conditions. An interesting feature of the author's results was that strict control must be maintained over the variables which were known to affect creep if a poor type of steel was to be avoided. On the basis of the author's results there was no indication that open-hearth steel was superior to electric steel at working stresses and temperatures, and the deterioration noted at high test temperatures and stresses might be insignificant at working stresses and temperatures.

Dr. R. W. Bailey (Metropolitan-Vickers Electrical Company, Ltd.) said he had felt for a long time—and had expressed the view on previous occasions—that we were not getting the use to-day out of carbon steels that we might, and if this abnormality could be removed and guaranteed not to be there, there would be a field for the further use of carbon steels. Tons and tons of steel could have been saved in the past if this had been fully exploited. He thought the title of the second paper too broad because there was a fairly wide range of steels being used in different forms of heat treatment, whereas the steels dealt with by the author were normalised and tempered wrought steels. That was shown by the curves and he urged that some sense of perspective must be observed in examining these curves. The curves which the engineer was most interested in—and to some extent, also, the steel maker—were those which gave the specific stresses, from which one could get some idea of the temperature at which the stress should be used in practice. That was the essential test. The heating test—the one in which the steel was heated to find out how it weakened—was an exploratory test and did not indicate how the material would behave at high temperatures for a long time.

The author had spent a good deal of time on rupture tests and had provided a considerable amount of valuable information. Personally, however, he had always felt that the Americans placed too much weight on the value of rupture tests. In the early days of the war a good deal of information on this was obtained from America, but we could not make much use of it because it was not the information which designers required. The designer wanted to know that the material would do its life all right, and as long as there was a sufficient margin of ductility it only required a few tests to ensure there was that margin of ductility. Then a good deal of the rupture testing could be passed over because it occupied time and did not give very much more information as to how long a piece would take to break.

Dr. H. A. Dickie (Messrs. Stewarts and Lloyds, Corby) thought that any contribution which would minimise the type of hot shortness which plain molybdenum steel suffered from was a valuable contribution. The author had done this by demonstrating the improvement brought about by the addition of 1 per cent of chromium. The results showed that the elongation was clearly improved, and, in addition, the life of the steel was considerably lengthened. It would be useful if the author would consider the minimum amount of chromium necessary to produce these beneficial changes. With the presence of 1 per cent of chromium—or 0·8 per cent as usually used at present—the steel was liable to form a martensitic grain structure instead of a pearlite structure, and this could only be avoided by an adjustment of the cooling range, but it would be best to avoid it altogether, if possible, by ascertaining the minimum quantity of chromium that could be added.

Mr. Glen gave a brief reply to the discussion and promised a full reply in writing.

(To be continued)

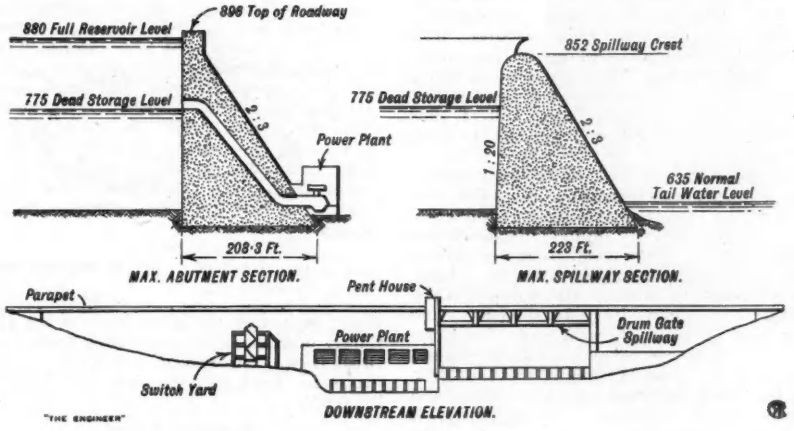
CANADIAN INTERNATIONAL TRADE FAIR.—Arrangements are now being completed for the Canadian International Trade Fair, which is to be held at Toronto from May 31st to June 12th. Over thirty countries will be represented at the Fair by the 1500 exhibitors. More than 200 firms are contributing to the exhibits from the United Kingdom.

Pipri (Rihand) Dam, India

THE Eastern Districts of the United Provinces in India are especially backward in irrigation facilities. But industrial development schemes for power production, it is felt, should also occupy a prominent place in post-war planning for this part of the country. The Pipri dam project envisages the harnessing of the waters of the Rihand River, a tributary of the Sone River, and aims at large-scale production of hydro-electric power.

Pipri is considered ideal for a dam site. Massive gneissose granite rocks, free from fissures and faults, expose themselves here in the bed of the river and on the flanks. The granite rock is sufficiently good to accommodate a dam 300ft high. Dr. J. L. Savage, chief dam designer of the Bureau of Reclamation, U.S.A., has inspected the dam site and has approved of the construction of a 300ft high concrete gravity dam. The country in the vicinity of the dam site abounds in minerals and other raw materials required for the setting up of basic industries.

The project is already under the consideration of the Provincial Government and work is expected to start on construction basis as soon as sanction is received. The salient features of the scheme are set out below.



SECTIONS AND ELEVATION OF PROPOSED PIPRI DAM, INDIA

The catchment area of the river at Pipri is over 5000 square miles and the weighted average annual rainfall is 56in. The average annual run-off from the basin is 6·9 million acre-feet and the calculated peak flood is 8 lacs cusecs.

The artificial lake created by the construction of the dam will submerge an area of 180 square miles, out of which 46 square miles lie in Rewa State and the rest in Tehsil Dudhi, District Mirzapur.

A concrete gravity dam with a gravity section 2500ft long and a spillway section about 550ft long will be thrown across the river. The crest of the spillway will be formed by four drum gates, each 28ft high and 135ft long. A highway bridge will span the four gate openings. A concrete apron, about 250ft long, with heavy retaining walls and energy-dissipating arrangement will be constructed at the toe of the spillway. The power-house will be 550ft long by 50ft wide and be situated at the toe of the dam on the right side of the spillway. The total quantity of concrete to be poured in the dam and appurtenant works will be 60 million cubic feet.

The proposed installed capacity of the power-house will be 230,000kW, capable of producing 1160 million units of electricity per annum at a cost of 78·2 lacs, inclusive of interest at 3·5 per cent per annum. This gives the cost of generation at 1·3 pies per unit.

A large block of power available from the Pipri dam would be utilised in electro-chemical, metallurgical and other basic industries close to the dam site. Artificial fertilisers, chlorine, caustic soda, bleaching powder, hydrochloric acid, calcium carbide, electric steel, rayon, cement, paper and other industries are expected to rapidly spring up in the area. The rest of the power will be utilised for industrial, agricultural and domestic consumption in the districts of Banaras, Ghazipur, Ballia, Azamgarh, Jaunpur, Allahabad, Fatehpur, Kanpur, Pratapgarh, Gonda, Bahraich, Faizabad, Basti, Gorakhpur, Deoria, Banda, Hamirpur and Jalaun and Banaras State. The Rewa State will also receive a share of the available power in lieu of permission to submerge a portion of their territory. Any surplus power would be available for sale in bulk to the neighbouring provinces and Indian States.

High-voltage transmission systems will link up the Rihand generating station with the existing steam and Hydro-power schemes in the United Provinces and will form a nucleus for future greater grid interlinking the United Provinces generating stations with the Kosi grid in Bihar, the Damodar grid in Bengal and the Mahanadi grid in Orissa.

The scheme is expected to cost Rs. 16 crores for generation and Rs. 10 crores for transmission. About 5 lacs tons of cement and 5000 tons of steel will be used in the construction of the project. The Government contemplate establishing a cement factory at Chopan (Mirzapur District) close to the dam site. Other building materials, viz., stone, sand and timber, are available at the dam site in abundance.

Besides cheap electric power, other direct and indirect benefits which are expected to accrue from the scheme are enumerated below. A minimum flow of about 6000 cusecs will be available throughout the year in the Rihand as well as in the Sone. This water can be usefully utilised for irrigating lacs of acres in the neighbouring province of Bihar, which will result in an increase in the production of food grains.

This assured minimum supply in the Sone and the Rihand will enable inland navigation to be carried out from Calcutta right up to the interior of the Rewa State, bringing the hitherto unknown and unexplored regions of the Sone Valley within trading distance of the important centres of the country.

The lake created by the construction of the dam would impound 400,000,000,000 cubic feet of water, which would permit the creation of fish hatcheries capable of supplying thousands of tons of fish all the year round.

The implementation of the Pipri dam project will considerably mitigate the intensity and

frequency of floods in the lower valleys of the Rihand and the Sone.

Large tracts of land in Eastern United Provinces will be supplied with water for irrigation by means of tube wells and river pumping schemes energised from this scheme.

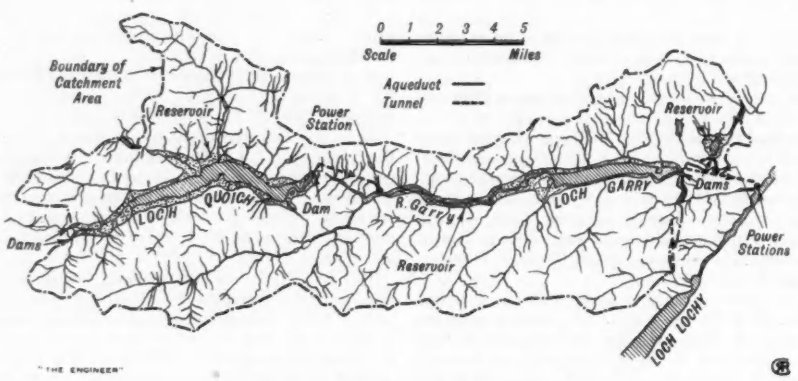
The Pipri dam project in its present form does not envisage the harnessing of the entire power potential of the Rihand and the Sone rivers. Investigations are also being carried out for a suitable dam site on the Rihand River at Obra, about 20 miles downstream of Pipri. The Obra scheme is proposed to be taken up as soon as the available generating capacity of the Pipri scheme has been fully exploited.

North of Scotland Hydro-Electric Board Garry and Moriston Schemes

THE North of Scotland Hydro-Electric Board has published two schemes intended to utilise the great water-power resources of Glen Garry and Glen Moriston in Inverness-shire for the production of about 384,000,000 units of electricity per annum. These schemes cover an area of 309 square miles north-west of the Great Glen, and they will provide power for future industrial development in the Inverness-Fort William areas and increase the electricity available in the whole of the Highlands and other parts of Scotland. It is the Board's intention to make electricity available to Fort Augustus and to the townships and many of the isolated houses in the Great Glen and Glen Garry and Glen Moriston.

Four attempts were made between 1928 and 1938 to develop the waters of Glen Garry and Glen Moriston. These promotions, which did not receive the approval of Parliament, were the West Highland Power Bill of 1928 and the Caledonian Water Power Bills of 1936, 1937 and 1938.

The Board's projects differ considerably from the previous schemes and take into account the objections raised in the past. For example, the Garry project, Constructional Scheme No. 24, differs from the earlier private promotions in two main respects. First, it is proposed to develop the water of Loch Quoich to the east, its natural course, and not to Loch Hourn on the west coast. Secondly, the amounts of compensation water proposed are greatly in excess of those of previous Bills, and the Board is prepared to construct and operate a fish hatchery. Consequently, it is hoped to preserve the stock of fish in the River Garry, which is regarded as being one of the chief spawning rivers for the Moray Firth salmon fisheries.



GARRY HYDRO-ELECTRIC SCHEME

GARRY SCHEME

The Garry scheme is estimated to cost £4,850,000, and will utilise a catchment area of 151 square miles to produce an average annual output of 170,000,000 units. On the Garry itself there will be two main dams and two power stations and a subsidiary development centred on Loch Lundie.

At the eastern end of Loch Quoich a dam, 806ft long and 107ft high, will be built across the Gearr Garry. From this storage reservoir the water will be led to a generating station of 20,000kW, discharging into Loch Poulary, on the River Garry.

At the eastern end of Loch Garry there will be a dam 1026ft long and 84ft high. From there the water will be conveyed to Invergarry power station on the north bank of the River Garry, near its outlet into Loch Oich in the Great Glen. This station will operate under a maximum head of 218ft and have plant of 20,000kW.

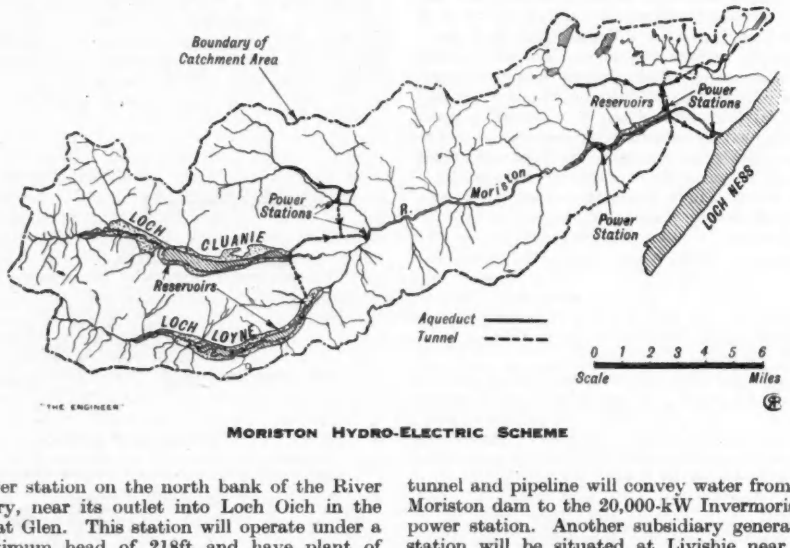
MORISTON SCHEME

The Moriston project, Constructional Scheme No. 23, will utilise the water-power resources of 158 square miles of catchment, most of which is in Inverness-shire and the remainder in Ross-shire, for the production of about 214,000,000 units of electricity per annum. At present prices the total estimated cost of this scheme is £8,000,000.

To develop the power resources of the River Moriston with Loch Cluanie and Loch Loyne four dams and four generating stations, with a total installed capacity of about 56,000kW, will be built.

Loch Loyne, which lies to the south of Loch Cluanie at the head of the River Moriston, will be raised by a dam, 1542ft long and 61ft high, and the water so impounded will be conveyed by tunnel and pipeline to Loch Cluanie. Loch Cluanie will be raised by a dam, 2015ft long and 108ft high. From this loch water will be led by tunnel and pipeline to a 17,500-kW power station near Ceannacroc Bridge. A subsidiary power station, to utilise the waters of the upper catchment of the River Doe, will be built to the north of the Ceannacroc station. The water discharged from this station on the Doe will be led into the tunnel between Cluanie and Ceannacroc and utilised again in the Ceannacroc power station.

On the lower reaches of the River Moriston two dams will be constructed, one near Dundreggan, 367ft long and 34ft high, and the other, to be called the Moriston dam, 658ft long and 95ft high, about 2 miles upstream from Invermoriston. The Dundreggan dam will serve a power station of 13,000kW capacity close at hand on the upper reaches of the loch formed by the Moriston dam. Thereafter, a tunnel and pipeline will convey water from the Moriston dam to the 20,000-kW Invermoriston power station. Another subsidiary generating station will be situated at Livishie near the Moriston dam, to utilise water from a number of streams which at present flow into the River Moriston and Loch Ness.



MORISTON HYDRO-ELECTRIC SCHEME

Canadian Power Frequency Conversion

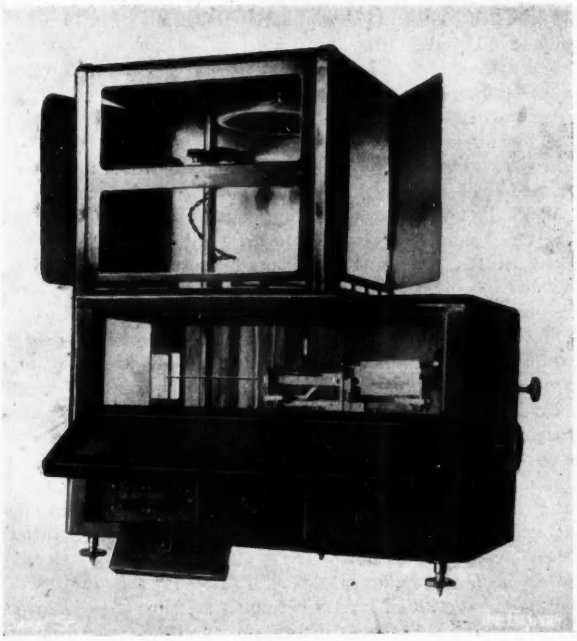
MAJOR changes in the generators of power-houses in Eastern Ontario and the great Beauharnois plant near Montreal will be made in conformity with a recent announcement that the Province of Ontario will switch over from 25-cycle to 60-cycle current. This will involve rewinding of the motors now delivering 25-cycle current to the Toronto area from the Beauharnois plant, the MacLaren-Quebec power plant on the Lievre River at High Falls, and from the Gatineau Power Company's plants on the Gatineau River, in the Province of Quebec. All the newer power developments on the Ottawa River and its tributaries, including the 480,000 h.p. plant at Rapides Des Joachims, the 160,000 h.p. plant under construction at Stewartville on the Madawaska River, and the projected plant at Chenaux Rapides will generate 60-cycle power. The conversion programme will mainly affect the Southern Ontario system of the Hydro-Electric Power Commission of Ontario. The frequency changeover represents in itself a big undertaking—estimated to cost about 191,000,000 dollars—but it is to be coupled with a programme of expansion which will require the expenditure of millions of dollars. "Hydro" officials have also announced a departure from the long-established policy of generating only hydro-electric power. In this connection, two steam generating units of 120,000 h.p. capacity are to be constructed. Additional steam-generated power will be obtained from the Polymer Corporation at Sarnia, Ontario.

Estimation of Moisture in Timber

IT is frequently desirable to know the proportion of water present in timber, but hitherto the acquisition of such knowledge has entailed the careful preparation of samples of wood, followed by a lengthy period of waiting while some distant analyst announced the results. By the use of modern electrical methods, employing portable apparatus, the maximum time to find the percentage of moisture in any type of wood is eight minutes.

Briefly, these new techniques for moisture determination use electricity in two entirely different ways. One of them involves the extraction of a sample from various parts of the wood, obtained by using a small-diameter drill on the timber at different points and collecting the material coming from the drill holes. The sample is then dried rapidly by means of infra-red rays, operating inside a sensitive chemical balance. In the other method it is not necessary to take a sample of the timber, for by pressing into the wood a series of diminutive metal spikes the percentage of moisture present in that area of the timber is indicated instantly on a dial of an apparatus attached to the spikes. This equipment makes use of the electrical conductivity of water and records the proportion of water in the wood where the spikes are inserted.

Such methods of moisture estimation do not appreciably degrade the value of the wood, since in the first method a drill of only $\frac{1}{16}$in diameter suffices to obtain a representative sample, while in the second method the spikes used are of very small diameter, and the holes created by both drills and spikes can be neatly filled in. With older methods of moisture testing, big cuts were usually made into the timber at suitable distances, the sawdust being carefully collected and sampled.



INFRA-RED MOISTURE TESTER

INFRA-RED MOISTURE TESTER

Although invisible, infra-red rays are capable of heating an object, placed at a suitable distance from the source of the rays, much more rapidly than can be done with visible rays. An example of this rapid heating is afforded in the sphere of paint drying, for a coat of paint which will take twenty-four hours to dry by normal methods can be dried completely within five minutes by the use of infra-red rays. In the infra-red moisture tester this rapid drying property of the rays is utilised in drying quickly a sample of sawdust or other form of finely divided wood when placed on the pan of a specially constructed balance.

A typical moisture tester of the infra-red type, made by Townson and Mercer, Ltd., of Croydon, is shown in the illustrations reproduced above. This instrument consists of a sensitive air-damped balance with a counterweight and a single pan above the beam, enclosed in a separate aluminium-walled chamber, with the weight transmitted through a supporting rod passing through a narrow hole. Above the pan is fixed a powerful infra-red lamp, running at a definite voltage. The lamp has a rhodium-plated reflector, which concentrates the beam on to the area of the pan, diffusing it sufficiently to give an even coverage. In the base of the cabinet is a transformer with two sets of tappings led out to a panel on the front, to give adjustment for the input voltage and for the voltage applied to the lamp, so that the strength of the infra-red beam may be adjusted.

A pointer on the balance runs over a scale directly graduated 0 to 5 per cent, in graduations of 0·2 per cent, which makes it easily possible to read with an accuracy of 0·1 per cent. By operating a knob on one side of the instrument a rider may be pre-selected into certain fixed positions so that the scale reading covers ranges of 0 to 5, 5 to 10, 10 to 15, 15 to 20 and 20 to 25 per cent respectively, when using a 5-gramme sample of wood. When wood with more than 25 per cent moisture has to be tested, a 2½-gramme sample is weighed out and the percentage readings doubled.

To test a sample, one of the adjusted pans, which are of polished aluminium, is placed in the instrument together with a 5-gramme weight and the zero adjustment is turned until the pointer registers zero, with the rider in the 0 per cent position. The weight is then removed and 5 grammes of the sawdust tipped on to the pan until the pointer once more returns to zero. The sample is then roughly levelled over the pan. The door in the weighing compartment is then closed, the rider position is pre-selected to the percentage range covering the moisture content that is presumed to be in the sample, and the infra-red lamp is switched on. Depending on the type of wood under test, the pointer will come to rest in times varying from three and a-half minutes onwards. In some types of wood, with a very slow evolution of residual moisture, it is possible to get reproducible results at five minutes, although perhaps the final reading cannot be obtained in less than ten minutes. A definite amount of water can be determined which should be added to these five-minute readings, particularly where the same type of sample woods are under review.

With this instrument tests have been made on finely divided wood, the voltage used on the lamp being 170, and it required a total of six minutes only to eliminate the whole of the moisture present, which in this case was 7·4 per cent. The moisture was eliminated from the wood progressively as follows:—After one minute 0·8 per cent was eliminated; two minutes, 3·0 per cent; three minutes, 4·8 per cent; four minutes, 6·6 per cent; five minutes, 7·1 per cent; six minutes, 7·4 per cent; while seven minutes also showed 7·4 per cent moisture content eliminated, thus indicating that all moisture was driven off. It follows that if testing a number of the same type of wood samples, and after four minutes of heating the indication is 6·6 per cent moisture, it can be safely inferred that the total water content is 7·4 per cent; in this way much time is saved when many samples of the same sort have to be handled.

AN ELECTRONIC MOISTURE TESTER

Within the past few years the science of electronics has been rapidly developed and applied to numerous industrial purposes, with the result that there are now available many ingenious instruments designed to perform, practically instantaneously, a task that used to require several hours, or even days, to accomplish. Such apparatus may incorporate rectifiers, amplifiers, electrical relays, &c., harnessed to accomplish some useful work. For example, the variation in conductivity caused by water in a sample can be made to indicate the proportion of water present.

ELECTRONIC MOISTURE TESTER

An electronic moisture tester, designed to indicate the moisture content of wood, made by the General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2, is illustrated herewith. The equipment is self-contained in a convenient carrying case and its operation merely entails inserting a testing head, which carries four spikes, into the wood to be tested, and making an adjustment on a switch.

The controls of the instrument consist of a panel equipped with an indicator, selector switch, a "set" standard switch and "percentage" moisture switch. The testing head consists of the metallic holder and the four insulated spikes, which are connected by flexible cable to terminals on the front of the instrument. The circuit is thermionically controlled, a low-tension battery being inserted through the front panel of the instrument and protected by a removable cover. The high-tension batteries consist of standard 1½-V torch batteries, mounted in a movable drawer in the base of the instrument. No connections have to be made when inserting fresh batteries, this being done automatically as the cells are put in. When the insulated spikes are inserted in the timber the approximate water content of the wood is shown by a dial on the instrument. As already indicated, the principle upon which the instrument works is the measurement of the electrical conductivity of the timber, which, of course, varies with the moisture content.

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NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

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THE NATIONAL COAL BOARD

RUMOUR has been persistent for some months that all has not been well with the National Coal Board. But rumour is proverbially a lying jade, and there are doubtless many who, either on account of political bias or for professional or monetary interests, take a jaundiced view of the operation of the nationalised coal industry. But there have not been lacking events in the organisation which pointed directly to a state of unrest. Some months ago Mr. H. Watson-Smith, an experienced mining engineer, who had served on the Reid Committee which reported in March, 1945, on the reorganisation of the coal-mining industry, resigned from the Production Directorship of the East Midland Region; and, about the same time, Mr. J. C. Gridley, the Marketing Director of the N.C.B., also resigned; and, in March last, Mr. F. Hunter, Production Director of the North-East Division, resigned, his deputy, Mr. H. M. Hudspeth, a well-known and experienced mining engineer, having done so some months previously. If these events were insufficient to cause anxious forebodings, the recent speech by Mr. Shinwell, the Secretary for War, ex Minister of Fuel and Power, and Chairman of the Labour Party, certainly succeeded in creating some consternation. Addressing the Co-operative Congress at Edinburgh on May 2nd, he said: "When the mining industry was nationalised—this had been on the Labour Party programme for fifty years—we thought we knew all about it; the fact of the matter was we did not." He said they found themselves up against extraordinary difficulties; and he continued, "we must be extremely careful that these difficulties do not ultimately destroy the whole conception and make it impossible to proceed further in the direction of nationalisation." Whether or not we agree with Mr. Shinwell politically and share or not in his ideologies, these expressions of opinion are, in the circumstances, not only those of a courageous, but of an intellectually honest, man. We know now that Sir Charles Reid had, on March 7, 1947, only some weeks after the vesting date, expressed to Mr. Shinwell his "deep concern about the way things were shaping."

On the evening of Thursday, May 13th, it was announced over the wireless that Sir Charles Reid, one of the two mining experts and Director of Production on the Coal Board, had tendered his resignation as the other members of the Board were not in agreement with him on many matters of policy. The loss to the Board of so experienced and capable a member is in itself a serious one, but the reasons he gives for his resignation are alarming and are calculated to induce a lack of public confidence in its activities. That Sir Charles Reid was not happy about the state of affairs became publically evident from his speech in Edinburgh on April 17th of the present year, on the occasion of the presentation of the Mitchel Hedges Trophy to Scottish miners for the best output record for 1947. He was told, he said, by all the miners' leaders that the conciliation machinery was all right. But it was not working. The output per man-shift at the coal face in 1938 was 2·9 tons, whereas to-day it was only 2·85 tons, although the proportion of coal cut by machinery was now 74 per cent of the total output, as against only 58 per cent in 1938. "We are putting into the pits day by day," he said, "great masses of machinery and it does not seem to matter what we do—output per man is not rising." On March 18th last he was so concerned about matters, and the non-agreement with his colleagues, that he submitted his resignation to the Minister of Fuel and Power, but eventually agreed to continue on the Board provided a full and impartial investigation by competent and independent persons into the entire organisation was made. Sir Charles Reid has given specific reasons for his resignation. He has no confidence in the Board or in the organisation which it has set up; vital changes seem to him necessary to make the organisation effective and efficient; he advocates a strong policy Board, whose members would be divorced from functional duties (he himself was Production Director). "Without the most radical alteration—from the Coal Board downward—both in regard to type of control and personnel, the nationalisation of the mines will prove a disastrous failure," he wrote to the Chairman of the Board on November 8th last. He desires to see complete decentralisation believing that the management of the collieries, speaking generally, is unhappy and uncertain of its position and the extent of its authority.

Two of Sir Charles' proposals appear to us to strike to the heart of the matter. They are that the Coal Board should be in the nature of a Policy Board divorced from functional duties; and that there is a need for decentralisation. It will be remembered by those of our readers who perused Sir Richard Redmayne's article, "Coal in 1947," which appeared in our first and second issues of January last, that he stressed the necessity for the realisation of these two desiderata if peace and prosperity were to return to the industry. The conditions—physical, technical and sociological—as between the various coalfields are so different that only those possessed of local knowledge and experience can deal effectively with the problems arising therein. As it is, to quote from a leading article which appeared in *The Daily Telegraph* of the 14th of the present month, "the dead hand of impersonal bureaucracy reaches right down through the organisation to the coal face, impairing efficiency and staying initiative." Many of the men, who, prior to the vesting of the industry in the State, had devoted themselves to its work as directors, and some in other categories, men who had grown up in and were intimately concerned with the industry—who were well acquainted with and versed in the *genius loci*, so difficult of comprehension to the stranger—had to seek other fields of activity when the mines passed out of their control, greatly to the loss of efficiency at the mines. For, perhaps, more than any other branch of industry, coal mining is dependent for its successful prosecution on personal responsibility, personal incentive and personal initiative. The present outlook is very depressing. Cost of production continues to rise, output remains almost stationary, voluntary absenteeism does not fall, the selling price of coal was never so high in peacetime as at present and the industry is being run at a heavy loss financially. There is one respect in which Sir Charles Reid would appear to be in error, namely, in his belief that State ownership of the industry is a necessary condition for the achievement of full technical reconstruction, for the same result could have been attained, and equally well carried out, under private enterprise by voluntary amalgamation of colliery interests. With the resignation of Sir Charles Reid there remains, on the Coal Board, but one mining engineer, Mr. Eric Young. One would have supposed that on a Board concerned entirely with coal-mining interests the preponderance of members would have consisted of mining experts representative of the several great coalfields. We await with interest the advent of the report of the committee set up by the Coal Board to take stock of the position reached in the development of the Board's organisation, and to advise whether any improvement can be made. Sir Robert Burrows, who on May 1st became a member of the Board and who, before its vesting in the State, was chairman of Manchester Collieries, has been appointed chairman of this committee, and, judging from his wide experience and impartiality, should deal adequately with the problems arising for its consideration.

JOHN HENRY HAMILTON AND HIS WORK

IN his recent Akroyd Stuart Lecture at Nottingham University College, Mr. H. J. Gibbons paid a notable tribute to the work of the late John Henry Hamilton, with whom he was, for so many years, closely associated. It is altogether fitting that the

influence of Hamilton on the development of the internal combustion engine should be recorded, and no man can be so well qualified for this work as one who, like Mr. Gibbons, worked with Hamilton for more than thirty years and remained in close contact with him until his death in 1932. While the evolution of the positive scavenge is, no doubt, the achievement for which Hamilton will be best remembered, it would be a serious mistake to suppose that this was his only contribution to the development of the internal combustion engine. In almost everything that he touched, Hamilton showed not only a powerful originality, but a singular apprehension of what was practical and possible. In this respect his intuition was of the quality which we find in all great designers, and, daring as he proved to be, what he did was bottomed in wisdom rather than in audacity. Nothing ever daunted him and with immense power of concentration he combined an imagination which was the astonishment of all who saw him in action. Mr. Gibbons shows, among other things, with what slender manufacturing facilities Hamilton could arrive at impressive results. The rapidity with which his mind worked and the extent to which he could make short cuts to his objective can have few parallels. Thus it is that an account of his accomplishments makes such good reading for the young engineer. We in Great Britain have ever been apt to undervalue the mighty contribution made to engineering progress by men of our own race. Hamilton himself was an extremely retiring, even a shy man. Let us not forget that his labours have left indelible traces and we may indeed apply to him certain words used long ago by the illustrious Condorcet: "In proportion as excellent productions shall multiply, every successive generation of men will direct its attention to those which are most perfect, and the rest will insensibly fall into oblivion. But the more simple and palpable traits which were seized by those who first entered the field of invention will not the less exist for posterity, though found only in the latest production"

Obituary

ALFRED WILLIAM BENNIS

As briefly recorded in our last issue, the death took place on Tuesday, May 4th, at his home, 3, Downside Road, Bristol, of Mr. Alfred W. Bennis, the chairman and managing director of Bennis Combustion, Ltd., of Little Hulton, near Bolton. His death, at the age of 78, will be widely regretted by engineers, especially those engaged in the power industry and the making of coal-utilisation plants.

Alfred William Bennis came of Quaker stock and he received his education at the Friends School, at Ackworth, near Pontefract. After attending technical classes in Bolton, he entered in 1886 his father's business, with which he continued a close connection up to the time of his death. It will be recalled that the business was started in Liverpool about 1870, when Mr. Edward Bennis joined Mr. Dillwyn Smith, of Philadelphia, and established works to develop the sprinkler type of mechanical stoker. A self-cleaning compressed air furnace followed after lengthy experiments, and a commercial stoker and furnace was produced. The firm moved to Bolton, and it was in those works between 1885 and 1888 that Mr. Alfred Bennis served his apprenticeship, after which he passed through the drawing office and the design departments. In a large measure, Mr. Bennis inherited his father's inventive genius and he greatly assisted in developing the sprinkler stoker with the compressed air furnace and later the coking stoker, and the air draught stoker. In 1889 Mr. Bennis was appointed assistant manager to the Deansgate Foundry Company, Bolton, a firm which was closely associated with the Bennis business and was later merged with it. In 1895 he became a partner and later became general manager and director of the firm of Edward Bennis and Co., Ltd. He was responsible for many patents relating to stoker and furnace design and to coal and ash handling plants. About 1904 the Bennis works were moved out in order to facilitate extensions to Little Hulton, near Bolton, where the business has since been carried on.

Quite early in his career Mr. Bennis became interested in the application of mechanical stokers to marine boilers and as far back as 1895 he equipped two Spanish ships with that type of boiler firing and personally conducted the trials which took place off the coast of Spain. At that time steam jets were used for producing the forced draught, and, with the necessity for conserving fresh water at sea, the stokers did not prove popular. With the production, however, in this country of the air-draught sprinkler stoker, Mr. Bennis, after trying it out on a Lancashire boiler in Yorkshire, in 1926, returned to the marine problem and in 1934 equipped the steamer "Manchester Hero," belonging to Manchester Liners, Ltd., with the Bennis system of marine stoking. The results obtained from this ship led the owners to equip several further ships with the same system. In 1936 the firm became a public company styled Bennis Combustion, Ltd.

Mr. Bennis joined the Institution of Mechanical Engineers in 1895 as an Associate Member and became a Member in 1899. He was also an Associate of the Institution of Electrical Engineers and a Member of the Institute of Fuel. Throughout his whole career he was keenly interested in methods of producing steam at low cost and he established a works magazine in which those ideas were promulgated. At a later date it was developed into a regular monthly journal under the title of *Cheap Steam*. Alfred William Bennis will be remembered by many as a keen mechanical engineer of original character, who served his firm well for over sixty years.

ERNST AUGUST JULIUS KOCH

MANY of our readers will learn with deep regret of the death at the age of sixty, in the Leatherhead Hospital on Friday, May 7th, of Mr. E. A. J. Koch, of Ashtead, Surrey, a well-known industrial consultant. Some years before the war he assumed British nationality. He was born at Neiderbrun, in Alsace, and received his early education at the Zabern Grammar School. From 1916 to 1917 he was trained at the German Railway Repair Works at Strassburg, and in 1919 he went to the Stuttgart Technische Hochschule. There, studying from 1919 to 1923, he gained his engineering degree. In 1924 he joined the Bemberg A.G. of Barmen, and in a short time was appointed chief engineer to the company's Italian works. When in 1929 the British Bemberg decided to build its Doncaster factory Mr. Koch was appointed chief engineer. On its completion he began to practice as an industrial consulting engineer with the firm of Wallace Gilbert and Partners, industrial architects, of Roland Gardens, South Kensington. Later, in 1932, he started to practice as an independent industrial consulting engineer at 64, Victoria Street, and was adviser to a large number of engineering and manufacturing concerns, including Hoover, Ltd., the Pyrene Company, Ltd., the Champion Sparking Plug Company, Ltd., Black and Decker, Ltd., Johnson and Philips, Ltd., and Wiggins Teape and Co., Ltd. Just before the last war Mr. Koch became consulting engineer to the Beecham Research Laboratories, Ltd., and was appointed development director to the company. He was largely responsible for the design and construction of the company's new laboratories at Brookham Park, Surrey, and also largely responsible for the introduction of high-pressure, hot-water domestic and process heating into this country. Mr. Koch was keenly interested in flying, and held a pilot's "A" licence, and he was an enthusiastic glider, and an instructor to the London Gliding Club at Dunstable. He was for many years a member of the Verein Deutscher Ingenieure, and a member of the Engineers' German Circle in London. In 1935 he joined the Institution of Mechanical Engineers. He made many friends and his death will be regretted widely.

BOOKS RECEIVED

Materials Handbook. By George S. Brady. Sixth edition. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 7 dollars.

Heat Engines. By S. H. Moorfield and H. H. Winstanley. Third edition. London: Edward Arnold and Co., 41 and 43, Maddox Street, W.1. Price 8s. 6d.

Modern Oil Engine Practice. Edited by E. Molloy. Third Edition. London: George Newnes Ltd., Tower House, Southampton Street, Strand, W.C.2. Price 30s.

Electronic Circuits and Tubes. By the Electronics Training Staff of the Cruft Laboratory. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 45s.

The Blueprint Language of the Machine Industries. By Henry Cecil Spencer and Hiram E. Grant. London: Macmillan and Co., Ltd., St. Martin's Street, W.C.2. Price 25s.

B.C.A.S. Handbook on Pneumatic Equipment. London: Compiled and published by the British Compressed Air Society, 94–98, Petty France, Westminster, S.W.1. Price 20s.

Daimler, 1896–1946: A Record of Fifty Years of the Daimler Company. By St. John C. Nixon. London: G. T. Foulis and Co., Ltd., 7, Milford Lane, Strand, W.C.2. Price 42s.

Electricity for Coal-Mining Students. Second edition. By J. Stevenson and W. Miller. London: The Technical Press, Ltd., Gloucester Road, Kingston Hill, Surrey. Price 8s. 6d.

Practical Design of Simple Steel Structures, Volume I. Third edition. By David S. Stewart. London: Constable and Co., Ltd., 10, Orange Street, W.C.2. Price 15s.

South African Mining and Engineering Year Book. 1947–48. Edited by S. R. Potter. London: Argus South African Newspapers, Ltd., 85, Fleet Street, E.C.4. Price 45s.

Jet Propulsion Progress. By Leslie E. Neville and Nathanial F. Silsbee. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 3·50 dollars.

Introduction to Electrical Engineering. By George V. Mueller. Second edition. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 30s.

Electro-Technology, Vol. I. By H. Teasdale and E. G. Walton. London: English Universities Press, Ltd., St. Paul's House, Warwick Square, E.C.4. Price 9s. 6d.

Motor Boat and Yachting Manual. By the Staff of *The Motor Boat and Yachting.* Fourteenth edition. London: English Universities Press, Ltd., St. Paul's House, Warwick Square, E.C.4. Price 8s. 6d.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

THE BRITISH MACHINE TOOL FUTURE

SIR,—The Machine Tool Trades Association, with great foresight, took steps towards the end of the war to look ahead to ensure the preservation of a strong and healthy machine tool industry. Accordingly, a very informative report was compiled and on August 30, 1945, presented to the Director General of Machine Tools. The report was undoubtedly compiled in the best interests of the country and dealt very exhaustively with the machine tool position in the future.

Now it had been thought by many that conditions after this last war might be somewhat similar to those conditions which prevailed after the 1914–1918 war, where large numbers of machine tools came on to the market, and the machine tool trade eventually found its orders were not sufficient to keep it fully employed. Therefore, this report of August, 1945, was quite rightly based on ways and means to prevent similar conditions. Accordingly, the report gave a list of American machines named "Gap" machines, suggesting they should have special attention as to their production in this country, particularly for defence purposes. Conditions, however, have turned out to be quite different from those expected in 1945. Our machine tool makers are full up with orders and long deliveries result. Notwithstanding the changed position since 1945, the Ministry of Supply has now compiled a long list of "Gap" machines to encourage firms to make these machines here.

Surely it cannot be thought we could be independent of America and win a major war by ourselves? There are already in this country all the actual American machines given on this "Gap" list, so if it is thought (notwithstanding the diminishing of our male population) that in another war we could make these machines as well as our own, then they are already available. Where, then, is the advantage to this country to try and get firms to copy them now? Shortage of dollars cannot be applied, as in 1947 the total imports of machine tools were only around £6½ millions, while imports of all other goods were over £1000 millions, and the Chancellor knows that it would be of little use, even if all imports of machine tools were stopped, and so he has stopped less essentials amounting to some £230 millions. Some firms that copied American machines have proved that the demand for each type and size is so limited that they actually have now in stock the ones they made, while on their own designed machines deliveries are for long periods. The United States are far more friendly to-day, yet in the past, even in the period of the two wars when they were not at war, they supplied all the machine tools that were needed.

The fact is that British-made machine tools fill the main requirements of this country very well, and only those engineering firms which need occasionally a special American machine have the advantage of getting the very latest high-production machine which had been tried and tested by American users on similar work.

Sir Frank Smith, who was then chairman of the Ministry of Supply Scientific Advisory Council, speaking to the Engineering Industries Association in September, 1946, criticised the machine tool industry that its exports in 1937 were less than £2 million, and said:

"I ask myself if the industry still possesses the spirit animating Maudslay, Whitworth, Nasmyth and others? Are we looking ahead? Do we visualise the needs of other industries for machine tools? More, do we create needs as we ought to? First the machine tool industry is a key industry and it is its duty to supply better and still better machines for the numerous other industries of this country."

Does it not appear that our country's needs will be best met by encouraging machine tool firms to produce the very highest types of their own design to give the increased output and accuracy so desirable; is it right to encourage them to merely copy imported machines and thus discard our own expert designers and technical men? If we are to maintain our position in the world's markets engineering firms must have access to the very latest machine tools and appliances. What do our industrial firms who use machine tools think of this copying craze, and why have they not been consulted?

British machine tool firms are booked up for long periods, but if they can manage further capacity, surely certain German machines should be their first consideration. The German machine tool competition has ceased and their extensive Continental and overseas markets are open—an entirely better proposition than copying American machines.

T. S. CATMUR, M.I.Mech.E.

London, S.W.1, May 18th.

INSTITUTIONS AND THEIR MEMBERS

SIR,—Your issue of April 16th contained a leading article on this subject. You bring to the limelight a grave difficulty in the organisation of large bodies such as the great professional institutions, but fail to offer any suggestions towards its resolution.

May I humbly suggest that a procedure, such as the following, could be employed when important issues are at stake:—

(1) The Council would send out a circular letter to the members, giving its proposal and a brief explanation.

(2) Members would be invited to send in brief criticisms and questions (limited to, say, 100 words each), to be received within, say, fourteen days of the issue of the circular.

(3) The Council would issue ballot papers, for a postal vote, accompanied by a précis of all the criticisms and questions (transcripts of the Members' comments would be better, if facilities allowed), and the Council's reply to the points raised.

In this way the ordinary members would be assured of hearing both sides of the argument before voting and the council would know that they had the *informed* backing of the majority of the members behind the result of the poll.

ROBERT J. ELDRED, A.M.I.Mech.E.

Ash, Surrey.
May 12th.

THE TREND OF WAGES

SIR,—Recently I was re-reading an address delivered in 1923 by Mr. Cecil Bentham, then President of the Manchester Association of Engineers. One short passage, which I will quote, is of particular interest, in view of present-day trends, a quarter of a century later, unfortunately in the opposite direction.

"The present is a time of all-round readjustment and devaluation, tending to correct the evils arising from the excessive expansion of the war period; this devaluation applies to staffs in much the same way as to men in the works and to material. The phase is unpleasant and no one likes it; but, in view of the fact that skilled fitter wages have been reduced from 88s. to 56s. per week and pig iron from £14 to £5 per ton, such a phase appears inevitable in order to maintain proportion." Will that former devaluation period be repeated in due time after the second world war, I wonder; or has the shilling to become before long worth only as much as the 1913 penny in purchasing power?

During an erection job in 1914 at Portrush, in the North of Ireland, I paid labourers 5d. an hour, that being the local rate then. But labourers now tend to get nearly as much as skilled men. In 1883, when I started as an apprentice in a Manchester engineering works, and also for years afterwards, an experienced tool fitter got 34s. per week of fifty-four hours and a labourer only about half as much. Nowadays, a fitter's rate is about five times as much and it tends to rise still higher. Draughtsmen, too, earn four of five times as much as they did fifty years ago, and good men are hard to get. These changes are within my own personal experience. Going a long way further back to the time when Wells Cathedral in Somerset was being built, it is said that skilled builders got only 1d. a day, and that a strike for 1½d. a day took place some 900 years ago. But at that time one could buy a whole sheep for 5d., as against about £8 to-day.

W. H. ATHERTON, M.Sc., M.I. Mech. E.

Derby, May 15th.

FORMATION OF BOILER SCALE

SIR,—Some fifty years ago I was puzzled over the flintlike nature of scale in a Lancashire boiler. It seems that the steam bubbles form on the heating surface and stay there for a time while they deposit their scale on the hot metal. The greater the steam pressure the longer the bubbles stick and the bigger they become and the more scale they deposit. After it is formed the scale remains free from water, as any such is driven off as steam. How, then, is it possible for a locomotive boiler to run with raw water? One would expect that the space between the tubes would be filled up with hard solid scale which could not be chipped off. Apparently this does not happen, but the solid matter falls as mud, where it can easily be washed off. This is due to the fact that owing to the motion of the locomotive boiler the steam bubbles are washed off as fast as formed and the scale does not stick to the tubes.

While one cannot shake a marine tank boiler to produce this effect, one could circulate the water by providing downcomers inside and this would have the same effect as the movement of a locomotive boiler. Only in recent times has this been fully recognised in water-tube boilers, for which many makers are now providing unheated downcomers to assist circulation. The whole subject of scale formation and the effect of high steam pressure on it in tank boilers requires careful investigation, particularly as even to-day the tank boiler has many advantages for marine use, and if its output of steam and efficiency could be raised, as the locomotive boiler results suggest, the benefit would be great.

C. TURNBULL

Newcastle-on-Tyne, 2,
May 15th.

TEES-SIDE INDUSTRIAL DEVELOPMENT BOARD.—The Tees-side Industrial Development Board has published an illustrated pamphlet directing attention to the facilities for industry within the area of its operations. The objects of the Board, on which local authorities, industrial undertakings, trade associations, trade unions and transport authorities are represented, are to further the development of new and the revival and extension of existing industries in the Tees-side district. The Board's address is North Eastern Bank Chambers, Morton Road, Middlesbrough.

Iron and Steel Corrosion

THE Corrosion Committee of the British Iron and Steel Research Association, notwithstanding the importance of its work to industry, seems to receive too little of the recognition and appreciation it justly deserves. At a recent conference in Birmingham we were given an opportunity to hear from the members of this Committee an outline of the considerable amount of work which has been and is being done at the Corrosion Laboratories at Birmingham and by the various sub-committees.

At this conference the discussion was opened by Professor G. Wesley Austin, the chairman of the Committee. He said the collection and circulation of data into the causes and effects of corrosion is no easy matter, but the goal is worthy of the expense and time spent. Much has already been achieved.

Mr. T. M. Herbert, the deputy chairman of the Corrosion Committee and chairman of the Protective Coatings Sub-Committee :—It may seem at first strange that a corrosion committee set up and supported by the steel industry should undertake research on protective methods, but the metallurgist still seems a long way from producing a cheap, non-corrodible structural steel, and it was therefore a realistic action to appoint a Sub-Committee in 1937 to study methods of protecting ordinary mild steel. There have also been criticisms that the work should have been done, not by the steel industry, but by those directly concerned in the manufacture of paints. However, there are methods of protection apart from paints, and the subject involves more than the composition of the paint, notably the problems of pretreatment and application. Thus the engineer, as the ultimate user, is vitally concerned in this matter.

The Corrosion Committee took the initial step of bringing together the three parties concerned—the steel maker, the manufacturer of the protective coating, and the engineer as ultimate user—to form with those engaged in the scientific study of the problem a disinterested and impartial body to study the protection of steel by all or any of the various methods available. The work so far performed or in hand has covered three main subjects :

(1) Methods of pre-treating iron and steel surfaces prior to painting. This was conducted largely in the paint research laboratory of the former L.M.S. Railway at Derby under Mr. F. Fancutt, and the results have been embodied in a brochure first issued in 1941, but now to be revised and reprinted. It shows that careful and thorough pre-treatment is half the battle in the preservation of steel by means of paint. The other half lies in the paint itself and therefore in direct and intimate association with the three organisations representing manufacturers of paints and bituminous products.

(2) Two-coat painting schemes suitable for brush application to steelwork prepared under average industrial conditions. For these tests a large range of formulated paints will be specially prepared involving twelve different media and a similar number of pigments. This programme covers three main lines, though others are contemplated later :—(*a*) A range of primers, followed by a standard finishing coat ; (*b*) a range of finishing coats, over a standard primer ; (*c*) bituminous and allied coatings.

(3) Metallic and other non-paint protectives. Here the object was to compare impartially under precisely similar conditions the behaviour of the various forms of metallic coatings—dipped, sprayed or electro-deposited as the case may be—both with each other and with the more traditionally used paint protection. In this series, too, certain less usual protectives, including vitreous enamel, are being included.

The Work of the Corrosion Committee

Remarks on the work of the Committee by Dr. J. C. Hudson, head of the B.I.S.R.A. Corrosion Laboratory, and official investigator to the Corrosion Committee :—In studying technical problems, such as corrosion, there are two broad methods of advance. The first is the pursuit of fundamental investigations designed to discover new ideas and provide a scientific background for the comprehension of the phenomena ; the second is the conduct of tests and practical trials with the object of improving existing materials and processes.

The strength of the Corrosion Committee's Organisation lies in the fact that it is well qualified to prosecute both these methods, as it is so constituted as to include both academic scientists and men with practical industrial experience within its membership. Scientists such as Dr. U. R. Evans, Dr. W. H. J. Vernon and their colleagues provide the fundamental background to knowledge of corrosion and new ideas. Three examples of this fundamental work are :

(i) The development by Dr. Evans and his collaborators at Cambridge of the so-called cementiferous paints. These are bound with an aqueous medium and the process of film formation closely resembles the setting of certain types of cement. Their protective properties when applied to steel exposed to certain types of corrosive conditions are remarkably good.

(ii) The design by the team of investigators at the Chemical Research Laboratory, Teddington, under the direction of Dr. Vernon, of the rotor test for the corrosion of metals immersed in sea water, aqueous solutions or other liquids. The specimens are mounted on the periphery of a rapidly rotating disc and the test has been proved particularly useful in simulating the exposure conditions of painting schemes applied to ships' bottoms moving through the water.

(iii) The introduction by Professor J. E. Harris of a leaching rate test for the efficiency of anti-fouling compositions. As is well known, under certain conditions the hulls of ships become covered with marine growth. The method of remedying this is to paint the bottom of the ship with a poisonous anti-fouling composition which prevents the settlement of the marine organisms. This composition only remains effective so long as the poisons, usually oxides or salts of copper and mercury, are liberated from the paint film into the sea water at an adequate rate. In its simplest terms, the leaching rate test is an accurate laboratory method of studying how this rate of liberation varies with time, and it affords a useful means of predicting the probable service behaviour of an anti-fouling composition.

The conduct of the practical exposure tests, service trials and the general work of perhaps slightly more immediate application to industrial needs falls to the B.I.S.R.A. Corrosion Laboratory. In this work the laboratory has the benefit of unstinted support and collaboration from its own and other industries and research bodies, as well as from individual members on the research committees.

The Work of the Sub-Committees

The Atmospheric Corrosion Sub-Committee, under the chairmanship of Mr. T. Henry Turner, has shown that the life of ordinary structural steel exposed to the atmosphere without a protective coating may be increased as much as threefold by the addition to the steel of small quantities of alloying elements, such as copper and chromium, without any undue increase in cost, considered in relation to the improved performance of the material.

The Protective Coatings Sub-Committee, under the chairmanship of Mr. T. M. Herbert, has conducted several extensive researches, the results of which have materially added to the knowledge of many types of protective coatings for iron and steel, more especially of painting schemes and metallic coatings used for protection against atmospheric corrosion. More recently, the Sub-Committee has entered into intimate collaboration with the paint and bituminous protective products industries and with the assistance of the representative organisations of these industries has set up a joint technical panel under the chairmanship of Mr. F. Fancutt, to make a detailed study of protective painting schemes for steelwork exposed to the atmosphere.

The Marine Corrosion Sub-Committee, with Professor J. E. Harris as chairman, has made a detailed study of the prevention of corrosion by sea water and the prevention of fouling. These researches are particularly applicable to the underwater protection of steel ships. A number of anti-corrosive compositions of proved performance have been developed which are regarded as setting a reasonable standard of efficiency for protection in this field. One of these has been used, by the Admiralty with satisfcation. The outer hull plating of the "Pretoria Castle" and the "Edinburgh Castle," constructed by Harland and Wolff, Ltd., for the Union Castle Mail Steamship Company, Ltd., was painted on the stocks with compositions and paints to the Sub-Committee's formulations. The "Pretoria Castle" docked a few weeks ago, about seven months after launching. On inspection 98 per cent of the bottom paint was found to be perfectly intact and unstained by rust.

Work on anti-corrosive compositions is continuing actively under the guidance of another joint technical panel, of which Mr. Fancutt is also chairman. In this case the collaborating organisations are the Admiralty, the British Shipbuilding Research Association, and the Association of Ships' Compositions Manufacturers.

The Industrial Waters (Corrosion) Sub-Committee, under the chairmanship of Dr. J. W. Jenkin, is responsible for the study of corrosion in all types of water installations. It has compiled a short popular brochure surveying knowledge and practical experience of corrosion by industrial waters, which should be published towards the end of this year.

Extensive tests on the corrosion of iron and steel in the soil were begun some years ago by the Sub-Committee on the Corrosion of Buried Metals, in collaboration with the British Non-Ferrous Metals Research Association and the Institution of Civil Engineers. The first sets of specimens are due for removal from the sites at which they have been buried in the summer of 1949.

There are certain purposes, such as the compilation of specifications for corrosion resistance or for the efficiency of protective coatings, for which it is necessary to investigate the methods of testing themselves rather than the relative merits of different materials. This is the function of the Methods of Testing (Corrosion) Sub-Committee, which is working in close collaboration with the British Standards Institution in this field. Research work by this Sub-Committee has already led to the production of a Provisional British Standard for protective schemes for light-gauge steel.

Practical Applications of the Committee's Work

To complete his brief survey of the work that the B.I.S.R.A. Corrosion Laboratory is conducting on behalf of the Corrosion Committee, Dr. Hudson added a few details to indicate the manner in which the results of these investigations receive practical application in industry.

The range of subjects varies from the protective schemes to be used for the steelwork of the new Severn Bridge or for painting electricity standards in Siberia to the problem of reducing the corrosive effects of hydrofluoric acid in the flue gases of pottery kilns. Advice has been sought regarding the rapid corrosion of the steel cars used for quenching coke, the protection of a steel pipe line to be used for a hydro-electric scheme in Scotland and the prevention of corrosion in steel barges.

He pointed out that despite the growing attention that is paid to the results of the Committee's work it is still not sufficiently well known throughout industry generally. It is in the national interest that steel should be used as economically as possible, particularly under present circumstances, where the demand far exceeds the possibilities of production. The dissemination of the knowledge gained from the Corrosion Committee's researches will materially help in reaching this ideal.

A Road Tractor for Overseas

For haulage work overseas the tractor and semi-trailer (or articulated) unit has proved a popular combination. A new bonneted tractor chassis, illustrated herewith, Model 2481, has been designed by the Associated Equipment Company, Ltd., of Southall, Middlesex, to meet "Matador" Mark III chassis have been incorporated. The engine, for example, is the well-known A.E.C. 9·6 litre direct-injection, six-cylinder oil engine, which develops 125 b.h.p. at 1800 r.p.m. The chassis is noteworthy, however, in being the first A.E.C. civilian goods

ROAD TRACTOR AND SEMI-TRAILER

overseas requirements. It is provided with left-hand control, the wheelbase being 12ft 1in and the overall width 8ft.

For semi-trailer haulage work, it is necessary that tractors and trailers may be quickly coupled together. The makers state this feature was checked during road tests conducted recently by independent observers when the tractor was uncoupled from a standard flat platform type semi-trailer, driven round in a confined space and recoupled to the trailer within only ninety seconds. In the construction of the tractor many of the proved units employed in the forward control A.E.C. vehicle to employ direct compressed air brakes.

Of unit construction with the engine and clutch, the gearbox is supported by a steel banjo pressing at the rear of the engine. Four forward speeds and one reverse are provided, the gear train being of the sliding mesh type, with constant mesh for direct and third speeds, which are engaged by means of dog clutches.

CHASSIS ARRANGEMENT

A constant-mesh auxiliary gearbox having ratios of 1·58 to 1 reduction and a direct drive of 1 to 1, provides in conjunction with the main gearbox five forward speeds. It is operated by a separate change-speed lever.

The fifth speed (direct) is obtained by engaging direct drive in the auxiliary gearbox. The clutch, gearbox and auxiliary gearbox described above, will be fitted to the first 100 chassis built. The fitting of auxiliary gearboxes will then be discontinued and subsequent chassis will be equipped with a new heavy duty single dry-plate clutch and a five-speed gearbox, the chassis type being then designated Model 2482. The new gearbox will have four constant-mesh speeds, first and reverse having sliding engagement.

The rear axle provides a final reduction of 7 to 1 by means of a double reduction gear unit, in which the first reduction is by a spiral bevel assembly and the second by a double helical pinion and wheel. An alternative ratio of 6¼ to 1 is available.

The foot-brake system is operated by compressed air supplied by a compressor driven from the gearbox, which delivers air via a reservoir to the brake cylinders; in the case of the front wheels the cylinders are mounted above hollow swivel pins through which the piston rods act. The rear brake cylinders are bolted to the frame and operate the brake camshafts through a mechanical linkage.

One of the illustrations we reproduce shows the new vehicle coupled to a Dyson flat platform semi-trailer, fitted with front jockey wheels the other shows the layout of the chassis.

Sealing Compound for Leaking Steam Flanges

We have received from Kilcoin and Partners, Ltd., 108, Cambridge St., London, S.W.1, particulars of a compound which has been developed for permanently sealing leaking flanges in steam pipes. This compound, known as "Furmanite," has a rubber base on which there is a high percentage of metal and a small amount of graphite.

When it is required to seal a leaking flange, a narrow strip of lead is first placed round the outer circumference and fastened firmly in place by a wire. The bolt or bolts nearest the seat of the leak are then removed one at a time and cleaned of any rust or other deposit. When each bolt is reinserted in its hole a special nozzle is screwed on it instead of the nut. A channel in the inner side of this nozzle connects the base with a tapped hole in the side. A pressure gun containing a cartridge of "Furmanite" is then screwed into the hole at the side of the nozzle. The heat of the steam in the pipe melts the compound, which is then forced by the gun along the length of the bolt into and between the flanges.

The lead strip round the flange forms a baffle against which the compound is pressed, whilst the heat of the steam vulcanises the rubber content of the compound to form a permanent seal. When the sealing compound sets the small graphite content prevents the adhesion of the metal to the pipe. When each of the faulty bolts has been treated the lead baffle is removed.

The Engineers' Guild

The annual general meeting of the Engineers' Guild was held in London on Wednesday, May 12th. The report of the General Council, which was presented to the meeting, showed that during the past year the rate of recruitment to the Guild had accelerated considerably, and that the roll now contained the names of one honorary member, 934 members, and twenty-four associates.

The major portion of the Council's report dealt with the deliberations concerning the incorporation of the Guild, it being explained that the prospect of a largely increased membership made it important to obtain the advantages of incorporation as soon as possible. The Guild had always looked forward to incorporation under the Companies Acts, but there had been several suggestions that a body dealing with questions of remuneration would be seriously hampered if it were not registered as a trade union, and the report recorded that some members of council had been impressed by the liberty and range of action that appeared to be afforded by law to trade unions. It was accordingly decided that the question should be thoroughly considered before the council could properly advise the Guild on this subject. A reference to the Guild's solicitor was therefore carefully drafted by a committee and critically examined in council in order that the pros and cons, not only of company and trade union but of any other available form of incorporation might be well ascertained, and the choice be such as would be best adapted to the very various employments of members of the profession and to the wide range of activities that their association might properly wish to pursue. Intimation of a conclusion on this subject was regarded as a necessary feature of an appeal to corporate members of the three institutions to join and support the Guild.

When the solicitor had had opportunity to consider the reference, further elucidation was

ought by discussion between him and representatives of the council before he submitted his considered opinion. It transpired that for all practical purposes the choice lay between registration as a trade union and incorporation under the Companies Acts. A trade union means any combination, whether temporary or permanent, the principal objects of which are under its constitution, "the regulation of the relations between workman and masters, or between workmen and workmen, or between masters and masters, or the imposing of restrictive conditions on the conduct of any trade or business, and also the provision of benefits to members." The report emphasised that very few professional engineers were "masters" and that it was at least doubtful whether, for the purposes of the statutory objects of a trade union, professional engineers would be held to be "workmen." Further, if the Guild were registered as a trade union and it could afterwards be shown that "the imposing of restrictive conditions on the conduct of" their business and "the provision of benefits to members" were not the "principal" objects under the constitution, the certificate of the Registrar that the association was a trade union might be withdrawn.

As a company, if the Guild were to take active steps to enforce its recommendations as to remuneration and conditions of employment in the manner open to a trade union, it would not be able to rely on the special protection against an allegation of conspiracy in restraint of trade, which is possessed by a trade union, and would be liable to be sued in tort. But it might well, if strongly supported by the profession, and having as its primary object the enhancement of the status of the profession, attain its objects by the entirely different method of negotiation and agreement. Having carefully considered this advice, the council took the view that the profession generally would more strongly support the Guild if it adopted the latter policy and method and unanimously resolved to recommend the Guild to apply for incorporation as a company limited by guarantee and not having a share capital. To implement that conclusion, the report explained that it would be necessary for members to agree to the appropriate amendment of the Guild's present constitution, and it intimated that the Memorandum and Articles of Association were now being prepared.

Another matter mentioned in the council's report was that as members were now being enrolled in all parts of the country, the early establishment of branches was very desirable. Fnally, the report contained some record of the proceedings at the special meeting of the Guild, which was held on March 10th, and of which an account was given in THE ENGINEER of March 19th.

It should be noted that the address of the Engineers' Guild is now 28, Victoria Street, London, S.W.1.

A Transformer Manufacturer's Jubilee

ON May 10th this year the British Electric Transformer Company, Ltd., Hayes, Middlesex, completed fifty years of transformer engineering and development. The company was formed in 1898, to manufacture the air-cooled radial transformer which was invented by A. F. Berry, and which, with minor modifications, is still in demand to-day. Berry was a junior engineer with the London Electric Supply Corporation, when he first became interested in developing transformers for supply systems. In 1897 he evolved the radial design, the success of which was due mainly to its effective ventilation, and simple, rigid mechanical construction, in which the conductors and, in turn, the coils, were tightly bound together to form a solid-massed winding on the core.

The first radial transformers were manufactured under licence by Naulder and Harrison, Ltd., London, but anticipating the expansion of electricity supply systems and the growing demand for transformers, Berry was instrumental in the formation of the British Electric Transformer Manufacturing Company, Ltd., in 1898. With Berry as electrical adviser the company started manufacturing transformers at the Globe Works, Woodfield Road, London. By 1900 the works were in full production and the early orders for air-cooled radial transformers included three 20-kVA, 2000/20,000-V, 50 c/s single-phase units for the Marconi Company's historic wireless transmitter at Poldhu.

To handle increasing business the company moved to the Hayes works in 1901 and its title at the same time was changed to the British Electric Transformer Company, Ltd. Until 1904 all the transformers built were air-cooled, but in that year oil-cooled units were introduced in anticipation of higher voltages and greater capacities. Later developments included tubular tanks and booster regulators, to counteract the voltage variations associated with longer mains. By 1910 the radial transformer was being built for voltages up to 20kV and capacities up to 1000kVA, and for the first time several units were subjected to short-circuit tests.

After the first world war the Hayes works were expanded to allow the manufacture of core-type transformers for three-phase supplies—the radial design being essentially a single-phase unit. During the next two decades the company played its part in many technical developments, including the high-voltage booster regulator, the "A"-type cooler, and tap-changing switchgear using first the drum controller principle, and, later, mercury switches.

In 1932 the company became associated with Crompton Parkinson, Ltd. Without any loss of identity this association involved many consequential advantages, including the joint use of the high power test station, which was opened at Chelmsford in 1939.

During the recent war the B.E.T. Company built 15,000 transformers of various sizes totalling more than 3,000,000kVA, and to-day work is in progress on units up to 60,000kVA, and the development of designs for voltages above 200kV. To study single phenomena at the higher voltages that will be used in the future a new high-voltage laboratory is being built.

Of the three brothers whose names are so closely associated with the technical development and expansion of the company, A. F. Berry is now retired; George Berry died in 1926, and F. E. Berry is still a director. No less than sixty-four of its present employees have served it for more than twenty-five years. This tradition of long service, which is associated with continuity of craftsmanship, is one of the factors that allows the company to face the future confident of maintaining the reputation it has established during the past half-century.

Technical Reports

The Winning, Harvesting and Utilisation of Peat. Fuel Research Station: Department of Scientific and Industrial Research. H.M. Stationery Office. Price 6d.—In this report an attempt has been made to gather together in concise form most of the information about peat, including data from Eire, from the Continent, and from N. America. Peat is commercially worked in Great Britain on a small scale, mainly for the production of moss litter and for agricultural and horticultural purposes. The pre-war output from commercial undertakings was about 120,000 tons per annum and only 2000 tons of that amount were sold as fuel.

Certain assumptions are made, on which are based estimates of the reserves of peat in Great Britain that might be made available. It is concluded that about 1,000,000,000 tons of air-dried peat, containing 25 per cent of moisture, could be won.

The heating value of peat as it occurs in the bog is only about 6 per cent of that of an equal volume of coal. This is due to the fact that peat in the bog contains 90 to 95 per cent of water. The water content in situ can be reduced by drainage to 85 or 90 per cent, but air-drying, after the initial winning, is necessary to reduce the moisture content any further. The peat substance when absolutely dry has a calorific value of 9000 to 9500 B.Th.U. per lb.

The cost of production of machine-cut, air-dried peat in Eire was about 24s. per ton in 1945, excluding interest and depreciation charges on the plant installed, estimated at 10s. per ton. The average wage of employees engaged on piece-rates, was about £3 per week. The report suggests that if allowance is made for the different wage-levels in this country, it is unlikely that machine-cut peat could be produced in air-dried form any cheaper than coal. The total cost of peat briquettes at a factory in Eire in 1944/5, when 16,400 tons were produced, was 54s. 9d. per ton. The briquettes contained 10 per cent of water and had a calorific value of 8300 B.Th.U. per lb.

Comparative costs of transport are also discussed and it is concluded that the cost of transporting potential heat in the form of hand-won or machine-cut peat would be about 2½ times greater than in the form of coal, because of the higher calorific value of coal, and differences in railway classifications. Obviously it would be more economical to utilise peat as near the source of production as is possible.

The report includes information from many sources concerning the use of peat as a domestic fuel in various forms and as an industrial fuel for steam raising. Data regarding the carbonisation of peat have also been included with details of yields and analyses of the products obtained.

In a concluding section, the report indicates the possibility, by extracting certain peats with solvents, of recovering waxes which might be processed to provide substitutes for high-priced, imported materials such as montan wax. It is implied that, if this process could be economically developed, the combined utilisation of peat as a chemical raw material and as a fuel, might be an attractive proposition.

Report on Investigation of the Benzole Technical Committee, 1942–1946, on Sludging and Corrosion in Benzole-Absorption Plants. Ministry of Fuel and Power. H.M. Stationery Office. Price 6s. 6d.—During the war the maximum production of benzole, the pre-war existing main source of toluole, for the manufacture of T.N.T., and of benzene for the production of styrene for synthetic rubber and of blending agents for 100-octane aviation fuel, was of paramount importance. Some benzole is obtained from the distillation of tar, but the main source is the gas produced at coke ovens and gas works from which it is recovered by washing the gas with an oil, creosote or a petroleum oil (gas oil or spindle oil) being mainly used. As explained in the introduction to the report, these oils deteriorate during use, the creosote tending to thicken and the petroleum oils to throw down a precipitate or sludge. This sludge, in particular, was causing considerable loss of benzole owing to its effect on scrubbing efficiency, on heat exchange, and to the necessity of closing down the plant for cleaning. Other troubles encountered were the corrosion of plants, mainly those using creosote.

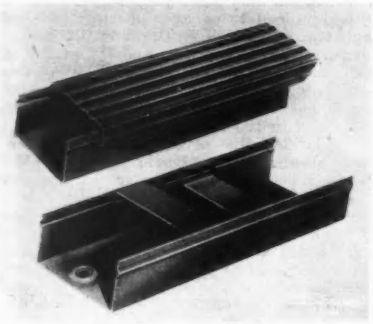
The report gives an account of the committee's investigations of the factors on which the rate of deterioration of petroleum oils depends, the mechanism of the reactions involved, and the problem of corrosion. Owing to the many substances present in the oils during use, both those washed out of the gas and those originally present in the fresh oil that may act either as reactants or catalysts, the problem of sludging is an extremely complicated one. Accounts of two of the committee's investigations, "Analysis of Sludges" and "Corrosive Action of Benzole-Absorption Oils," have already been published by the Society of Chemical Industry. The report, however, gives under one cover a complete record of the work of the committee, the various investigations and their interrelation, and of the information accumulated, and should provide a useful starting-point for further investigations.

Books of Reference

The Railway Handbook, 1947–48. London: *The Railway Gazette*, 33, Tothill Street, S.W.1. Price 5s. net.—This, the sixteenth, edition of this useful and comprehensive handbook, has been extensively revised and brought up to date. It contains a number of new and revised tables and, in view of the nationalisation of British railways, will be the last of its kind to record details of the individual companies. This book is so well known to all who are interested in railways that we need say no more than that it is as comprehensive, and will be found as reliable, as its predecessors.

Channel Conduit Wiring

We have received details of the channel conduit system of wiring, which was designed by Channel Conduits, Ltd., 13–14, Great Castle Street, Great Portland Street, London, W.1, to simplify new electric wiring installations by providing ready accessibility and adaptability. The system is particularly useful where the installation requires a large number of wires and circuits, and offers the important advantage that extensions and alterations (in factories, laboratories and test rooms, for example) can be carried out economically, quickly and with minimum inconvenience.

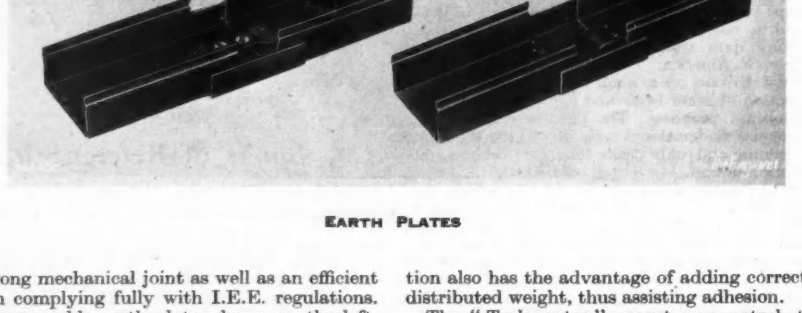


COVERING AND WIRING CLIPS

Simplification of installation and maintenance is achieved by the use of rectangular section conduit, comprising 12ft lengths of steel channel members or "casing," a complete range of accessories and 20 s.w.g. corrugated steel covering or "capping," which is sprung on to the channel member or accessory. The casing is made from 16, 18 and 20 s.w.g. steel in sizes 1in by ½in, 1in by 1in, 2in by 2in, 3in by 2in, and 4in by 3in, with capping and accessories to suit, thus providing a range to cater for the majority of industrial wiring applications.

The insulated wiring is secured by wiring clips fixed in either of the alternative positions shown in the lower half of the smaller illustration and the capping is firmly secured by the spring grip design and the dimpling of casing and capping. Fixing of the 12ft length of casing is by means of reinforced countersunk holes at 2ft intervals, for wood or metal screws, while lengths of casing and accessories are connected by earth plates embodied in the accessories or fitted to the various types of connectors.

As shown in our second illustration, two forms of earth plate are available, each being provided with two pointed grub screws at each end. When tightened, these grub screws form a strong mechanical joint as well as an efficient earth complying fully with I.E.E. regulations. The removable earth plate, shown on the left, as used for a running connector, is screwed to the base of the connector. The second form of earth plate, shown on the right, is riveted to the base of the connector and is used for joining conduit and accessories up to 2in by 1in.

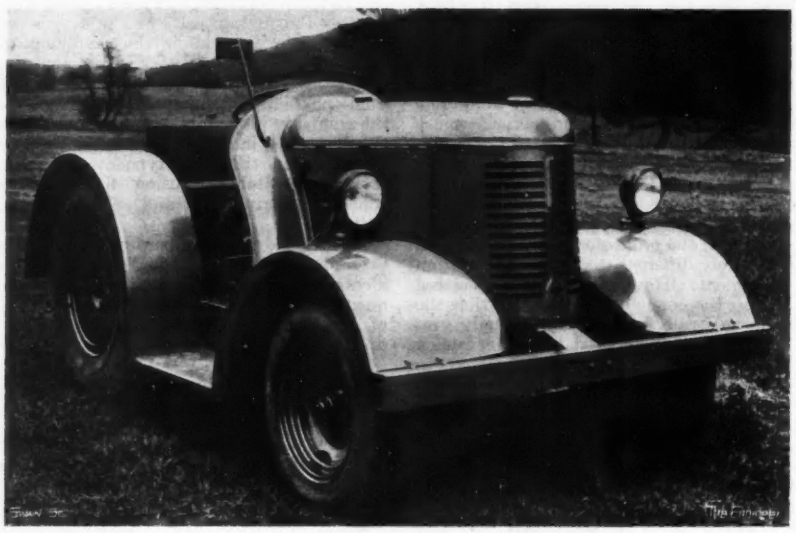


EARTH PLATES

From this brief description and the accompanying illustrations, it is evident that installation work can be done simply and rapidly with the channel conduit system, and that the task of maintenance or extension is made relatively easy. We are informed that this system is widely used by the Admiralty for work connected with the testing and development of radar and that channel conduit is approved by the Postmaster General for use on large or small private branch exchange installations.

An Industrial Tractor

An addition to the range of tractors made by David Brown Tractors, Ltd., is a new industrial model, to be known as the "Taskmaster," illustrated herewith. It is a medium-duty tractor, and the manufacturers state that it complies fully with the Road Traffic Act. Two independent braking systems, speedometer and lighting equipment fully comply with regulations. Mudwings front and rear are fitted, and it is interesting to note that they are constructed from ⅜in steel plate. Besides ensuring long life and immunity from denting from any but the heaviest bumps, this heavy construction also has the advantage of adding correctly distributed weight, thus assisting adhesion.



"TASKMASTER" TRACTOR

The "Taskmaster" operates on petrol, the engine being a David Brown four-cylinder, overhead-valve unit of 2523 cubic centimetre capacity, designed to develop 39 b.h.p. at 2200 r.p.m. The four-speed and reverse transmission is, as one would expect from this manufacturer, David Brown throughout. It is mounted in the tractor main frame and is easily accessible as a unit. Wheel equipment consists of dual-purpose rear 9·00 by 20 heavy-duty pneumatics, giving a good combination of traction under "off-the-road" conditions, and a smooth ride on hard road surfaces; front pneumatics are 5·50 by 16.

The low overall height of the vehicle (53½in) is some 2in lower than corresponding American tractors, a particular advantage for airfield work. Its small turning radius of 10ft, together with the short overall length of 9ft 1in, makes it manœuvrable in confined spaces, a useful feature when operating in small loading bays. A six-position towing hitch giving drawbar heights above ground level from 12in to 26in is fitted as standard equipment. For aircraft haulage duties, a regulation Air Ministry towing hook can be fitted as an alternative.

The tractor is essentially a short-haul vehicle, but the manufacturers have given considerable thought to the question of operating comfort and a good average top speed. Short haul means journeys up to about 20 miles, and for these jobs the maximum speed of 21·6 m.p.h. can be obtained. Drawbar pull at the standard tractor weight of 4368 lb is 3500 lb. Assuming a rolling resistance of a pneumatic-tyred trailer to be 40 lb to the ton (a conservative figure) on level dry concrete the tractor should be capable of hauling about 87 tons.

Maximum Demand Alarm

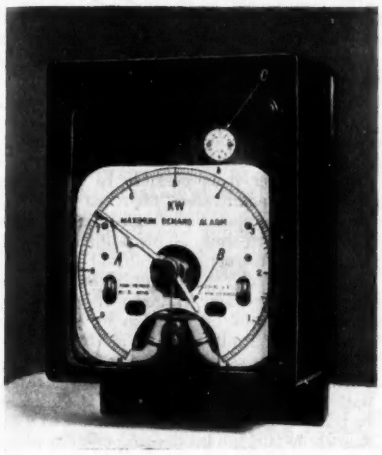
A device, giving advance warning when a consumer is approaching maximum demand on a three-phase electricity supply system, has been developed by Ferranti, Ltd., Hollinwood, Lancs. It can be supplied for operating on the basis of kilowatt or kilovolt-ampere (over a limited range of power factor), and for three-wire or four-wire unbalanced load supplies.

Briefly, the Ferranti three-phase maximum demand alarm consists of an integrating unit with a synchronous motor resetting mechanism operating every five minutes; an adjustable pointer which can be set by hand to the stipulated maximum demand, and a pair of contacts for operating a separate warning bell or lamp external to the equipment.

The apparatus, which is illustrated herewith, is designed for connecting to the supply in the

same way as a standard three-phase, three-wire or four-wire meter. In operation the synchronous timing element is set to coincide with the first five minutes of the tariff demand period, and the pointer A is then set to the specified value which is not to be exceeded.

As the demand period proceeds a small arm B geared to the integrating unit moves round on the same pivot axis as the setting pointer at a rate proportional to the total three-phase load. If the average load is below the set value for the five-minute period controlled by the synchronous timing element, the small arm will not reach the setting pointer and will return to its original position at the end of the interval. On the other hand, if the average load exceeds the set value, the small arm will reach the setting pointer before the end of the five-minute period, causing a pair of contacts to



MAXIMUM DEMAND ALARM

close and operate the warning bell or lamp. These contacts will remain closed until the end of the five-minute period, after which they will open due to the resetting operation.

The warning thus obtained means that if the average load during that five-minute period were maintained for the full thirty minutes of the demand period, the demand for tariff purposes would exceed the value of the alarm setting.

An important characteristic of the device is that the duration of the warning indicates the seriousness or otherwise of the excessive load. Should the warning last for half a minute or less it would be known that there was no great urgency for load reduction, although the position should be watched during the later five-minute periods. But a warning lasting more than half a minute would indicate that the load should be reduced with the utmost speed. The warning would be repeated in each succeeding period if the excess load were allowed to continue. If the dial C of the timing element can be observed at the moment the warning starts the amount of load reduction can be determined. For example, if the warning starts at the end of three minutes the load should be reduced by two-fifths, i.e., by one-fifth for each unexpired minute.

Sometimes a continuously ringing bell may be used. This continues to ring until reset by hand, so acting as a constant reminder of the necessity for load adjustment, even after the three-phase maximum demand alarm has reset itself.

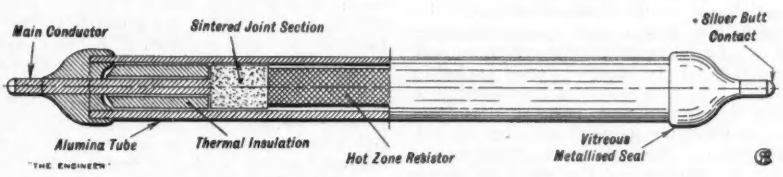
To set the adjustable pointer by hand the milled knob projecting in front of the glass window is depressed, engaging the pointer, and is turned to the required setting, after which the knob is held away from the pointer by a sealing device which prevents unauthorised interference. Since the alarm setting dial is 13in long an accurate setting can readily be obtained. As stated above, the alarm medium does not form part of the apparatus, but the alarm contacts actuate an auxiliary relay which is fitted inside the case.

High Temperature Resistors

INDUSTRIAL furnace heating demanding elevated temperatures presents no great problem, provided that individual resistor requirements are adequately fulfilled. Thus, the important temperature zone of 1350 deg. to 1450 deg. Cent. is met by utilising molybdenum in a suitable protective atmosphere of silicon-carbide, where oxidising conditions prevail; to some extent, too, aluminium-iron-chromium alloys for the lower and platinum for the higher temperatures are employed.

Retention of the electrical and metallurgical characteristics, as well as the well-known physical properties of tungsten and molybdenum, though often desirable, is precluded in furnace atmospheres including oxygen, sulphur or carbon, since short life following rapid deterioration inevitably occurs at temperatures far below those required for service.

Originally the logical step towards eliminating the protective atmosphere in a furnace chamber involved the hermetic isolation of the heating



HIGH TEMPERATURE RESISTOR

elements, which were then virtually encased in their own refractory compartment, whilst enveloped in protective gas—normally hydrogen. Thus, amorphous carbon or graphite bars and rods, and even silicon-carbide rods, in addition to metallic resistors of tungsten and molybdenum, were clad in tubes and shaped sections of suitable refractory metal oxides, such as alumina. Later, the availability of refractory tubes of aluminium oxide and aluminium silicate, having improved impermeability and high thermal shock resistance properties, in conjunction with the development of more efficient forms of terminal sealing, permitted resistors of this type to function without a protective gas within the envelope.

In this field, before the war, particularly on the Continent, valuable research work was undertaken, with the recorded result of significant advances in the design of resistors embodying vacuum-tight joints between thin refractory sheaths and the conducting component. Therefore, metallic resistors, capable of operating at high temperatures without a special atmosphere, were a practical possibility. More recently, another interesting development* in connection with non-metallic resistors, has been reported. Silicon-carbide, when provided with several glazes, mainly of aluminium oxide, is claimed to be impervious to oxygen, at high working temperatures.

The ideal resistor is one possessing a negligible temperature coefficient, where no change of original state occurs over infinite periods of operation at temperature, regardless of furnace atmosphere and the added strain of controlled load modification.

With a view to incorporating modern methods and materials available, new resistors are being developed by S. H. Parsonage, A.M.I.E.E., 42, Pall Mall, London, S.W.1. These resistors are believed to represent an appreciable advance in practical performance, as distinct from laboratory technique. As illustrated herewith, the unit consists basically of an aluminium oxide tube, into which is introduced a relatively free and flexible tungsten or molybdenum component, suitably modified physically so as to provide maximum electrical resistance—and, therefore, develop maximum heat—in the centre portion or hot zone, the connection terminals at the sealed extremities remaining comparatively cool. For example, at a furnace temperature of 1400 deg. Cent., the terminal temperature would be approximately 400 deg. Cent. Although fully appreciating the advantage of parallel operation, it is always most desirable to connect resistors in series or in series-parallel groups. Thereby, relatively high voltages are available to overcome any indifferent terminal contact resistances which conceivably may occasionally arise, in spite of the silver butt contacts employed. Furthermore, small currents only have to be handled, compared with the heavy currents at low electrical pressure associated with parallel connections.

Joints between sections of tungsten and molybdenum resistors may be electrically butt-welded or better, made by resistance sintering. In this context, a characteristic (usually a detrimental one) of high-grade refractory tubes, has proved of vital importance in facilitating the development of these resistors: when operating at high temperatures, they remain substantially impervious to most but not all gases. Thus, as is well known, hydrogen is relatively free.

Experience clearly indicates that, in service, resistors of tungsten or molybdenum when clad in aluminium oxide or similar refractories, must have ample mass and be liberally rated electrically so as to prevent easy overload and provide really reliable performance. Furthermore, adequate physical support is essential; otherwise sagging is certain. Again, resistors used vertically instead of horizontally must be arranged so that the centre of gravity is never away from the axis; for, if so, leaning, bending and ultimate refractory fracture are inevitable. The high density of tungsten and molybdenum coupled with the very high internal temperature—compared with the surface value—of resistors of this type obviously tend to facilitate their own distortion. The smallest size of tube recommended for industrial use is 18in long by ¼in diameter, the nominal rating being about 250W.

* See F.I.A.T., No. 924.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1.

GLOSSARY OF WELDING AND CUTTING TERMS: PART TWO

No. 499: Part Two. This additional part of B.S. 499 has been produced in conjunction with the Industrial Radiology Group of the Institute of Physics. It deals with surface imperfections and internal defects in the weld or adjacent metal which can be identified by radiographic means. There is a standard definition of each term, together with a description of the radiographic appearance. Where alternative terms are known they are grouped together, those given first being recommended for use, and the others being deprecated. The standard covers twenty-nine main terms, some of which have subsidiary terms. There are twenty-seven illustrations on art paper, seventeen of which are half-tone reproductions of radiographs or macrographs. The Foreword explains that the radiographs have been selected with the object of illustrating the salient features of the defects and discusses some of the difficulties of interpretation. The publication does not purport to give standard radiographs or standards of acceptance; its principal object is to standardise the terms used in radiographic reports and to provide, by means of descriptive matter and illustrations, an indication of typical imperfections and defects. Nevertheless, it is hoped that this part of B.S. 499 may assist in the preparation, in due course, of other standards dealing with the application of radiography to welding. Price 2s. 6d. each, post free.

Some Problems Encountered in the Lubrication of Steam Turbines*

By R. LOWE, B.Sc. (Eng.)

(*Continued from page 483, May 14th*)

IT was mentioned earlier in this paper that water vapour can be drawn into the bearing housings and so gain entry to the lubricating system. Pure water is not in itself harmful to lubricating oil, and will separate out very quickly so that it may be tapped off at regular intervals from the bottom of the main oil tank.

Water can, however, be an important contributory factor in the breakdown of an oil. It will combine with the oxidation products in the oil and provide favourable conditions for violent sludging.

Water vapour and air together cause rapid rusting of iron or steel, and iron rust is a powerful sludging agent when mixed with warm mineral oil. The reason for this is that rust combines to some extent with the acid oxidation products of the oil, and the reaction produces soaps which are precipitated in the form of sludge. The iron oxide also has a very strong catalytic action on the oil, accelerating oxidation and causing the oil to throw down asphaltic compounds.

Water corrosion of any parts of a turbine must therefore be avoided to the utmost possible extent. Most subject to water corrosion are the portions of the shaft on either side of the journals, the internal surfaces of the couplings and shaft ends and the internal surfaces of the oil tank which are above the normal level of the oil. The rusting on the shaft and coupling surfaces usually takes the form of a loose blistery growth which adheres very lightly to the steel. It is easily washed off by oil being splashed on, and subsequently thrown off. Surfaces covered by a continuous flow of oil are not subject to corrosion. In the oil tank the rusting occurs first in the form of blisters at the points where globules of condensed water vapour collect. These blisters of rust then grow almost in the formation of icicles until vibration or their own increase in weight causes them to fall into the oil. "Icicles" of rust up to 2in in length have been known to form. The iron oxide thus collected in the oil will cause deterioration which will develop at a rapidly increasing rate.

An instance of the dangerous rate which sludging may quite rapidly attain is shown by the case of a turbine which quite suddenly developed governor trouble after having operated satisfactorily for some years. The governor and relay gear were opened up for examination and it was found that the breakdown of the lubricating oil had become so intense that the governor pilot valve was almost completely restricted from moving, the result being that the machine was in a highly dangerous condition, and dependent only on its overspeed governor for tripping in the event of a runaway.

It is an interesting fact that the smallest particles of sludge or solid impurities in an oil form nucleii for the formation of further deposits and sludging therefore continues at a rapidly increasing rate. The practice of continually centrifuging or filtering oil is therefore to be highly recommended. The fact that a centrifuge aerates the oil and thus tends to increase oxidation can be completely offset by the use of a suitable oxidation inhibitor.

I would like to digress for a moment and describe another experience of sludging caused by iron oxide, not derived in this instance from corrosion, but from paint pigment. It has been common practice for many years to paint the inside of turbine bearing housings so as to provide a smooth and clean surface for drainage of the lubricating oil, and also to reduce the surface area subject to corrosion. The paint used is a high quality, hot oil-resisting red enamel in which the pigment is red iron oxide and the enamel under normal conditions has been found to be completely resistant to the action of warm lubricating oil. During the war, however, the quality of the enamel suffered, and in this particular case the oil attacked the enamel. The action became noticeable first as a disappearance of the gloss on the paint which then blistered slightly, became powdery and finally washed off into the oil. It happened that the oil in this machine also suffered at this time from ingress of water arising from excessive gland steam with the result that the conventional oil being used first rapidly discoloured, and then in the course of only a few running hours began to deposit sludge so rapidly that the centrifuge was unable to deal with the quantity and choked up. There was no alternative but to open up all the bearing housings and remove all traces of the paint, and it was decided to repaint the inside surfaces with another oil-resisting enamel, this time, however, white in colour and without any iron content. Unfortunately, this enamel proved to be even less resistant than the first, and almost as soon as the machine ran the enamel was found to be deteriorating and flaking off into the oil. The centrifuge was able to deal with the resultant deposit which caused hardly any sludging, but did tend to prevent the demulsification of the water from the oil. Because of this experience it was finally decided to remove all traces of the second coat of paint and leave only clean bare metal surfaces. The original practice of painting bearing housing surfaces was intended to bind down any loose sand particles which could not be cleaned out by ordinary fettling, but it is doubtful whether any paint, however high in quality, is satisfactory for large high-temperature machines. A more satisfactory method is to shot blast all surfaces exposed to lubricating oil.

Because of the activity of iron rust as a sludging agent, it is very important to reduce the quantity of water entering the lubricating system to a minimum, and this is a difficult problem for designers. The main source of water entry is steam from the glands blowing on to the bearing housings and being drawn in through the oil baffles. A certain amount of steam leakage at the glands is inevitable, however fine the gland clearances are set; but much can be done to reduce entry of water by correct control of the sealing steam. All turbine operators should be trained to run their machines with the minimum quantity of steam necessary to prevent a fall in vacuum and in the case of two-casing machines should be trained to vary the quantity of sealing steam with the load on the machine. It is all too common to find drivers who like to see the turbines in their care with plumes of steam blowing from the gland vents instead of barely perceptible wisps. By careful operation the quantity of water drawn off from a turbine lubricating system can be reduced to 4 or 5 gallons per week, but 8 to 16 gallons of water per week may be regarded as normal.

An improvement in the water condition in a machine can be effected by ventilating bearing housings, oil return pipes, and tanks, and experiments are still proceeding in this direction. A small-cowled ventilator on the bearing housing breaks the internal vacuum and reduces the tendency to draw in water. Also small-cowled ventilators on the return oil pipes or sight boxes are helpful in reducing the amount of water vapour carried into the tank.

Experiments are also being conducted in the use of oil tanks with various linings, such as Bakelite, or with galvanised surfaces, but the disadvantage of these is that porosity of the protecting surfaces or the minutest puncture in them will permit rusting under the surface. The protection eventually flakes off and the last condition may well be worse than if an ordinary mild steel tank had been used. Stainless steel would make an eminently suitable material, but on the score of expense has not met with much favour. A much more effective method is to treat the oil itself with a rust inhibitor which can be deposited by the oil on all surfaces normally subject to corrosion. Such inhibitors are readily available and many modern turbine oils are treated to prevent rusting as well as oxidation and foaming.

A very striking demonstration of the value of rust inhibitors was obtained in an experiment which the British Admiralty recently carried out in a drastic test on a destroyer. The vessel had a turbine installation of some 30,000 s.h.p., with two 300-gallon capacity lubricating systems. From each 150 gallons of oil were removed and replaced with sea water, and to one a quantity of rust inhibitor was added. The destroyer was then steamed normally, and contrary to all expectations no trouble was experienced. The turbines ran excellently and bearing temperatures were normal. After six months the vessel was docked and the turbines examined. Not a trace of rust was found in the machine in which the inhibitor had been added, while the other was a mass of rust everywhere except in the journals. The couplings were rusted up solid, and the shaft surfaces were like emery cloth. This experiment and the experience gained from the use of various types of oil during the war has shown the great advantages to be gained by the use of suitable inhibitors.

Many of the inhibitors used in turbine oils are soluble in water, so that if excessive quantities of water are made in the lubricating system the inhibitors may be leached out of the oil entirely. In choosing an inhibited oil an operator should therefore determine whether or not the inhibitors are water soluble, and if they are whether it is possible to obtain the inhibitor in concentrated form so that the normal strength may be maintained by additions from time to time. This point is of great importance because certain inhibited oils depend to some extent on their inhibitors for the attainment of necessary values of film strength.

Another point of importance in connection with the use of inhibited oils is the question of mixing—for example, in the case where it is intended to replace an ordinary straight oil with an inhibited type. It is desirable before putting in the new charge of oil to wash out the whole turbine lubricating system with a suitable degreasing and degumming agent. The reasons for this are several. The straight oil may be produced from a different base crude from the inhibited oil, and the mixture may cause precipitation of asphalty compounds. If the two oils do mix satisfactorily and any appreciable quantity of the first is left in the system, then the effect will be to dilute the inhibitors and reduce their effectiveness. A further reason is that an inhibited oil is usually detergent and will remove any asphalty or gummy residues which may be left in the turbine, but in so doing will use up inhibitor and will also carry the gums in suspension and so provide suitable conditions for sludge formation. Where straight and inhibited oils are being used in the same station great care should be exercised in the identification of the various types of oil so that no possibility of mixing can occur. Care should also be taken to ensure that the driver's hand oil cans are filled with the same type of oil as is in the machine, since drainage from points lubricated by hand is often into the main system, and over, say, a year's running the amount of oil used in hand cans may be quite considerable.

Two methods of degreasing are available, termed "vapour phase" and "aqueous washing" respectively. A third method of washing by means of a highly detergent oil is being developed, but is not yet generally available. Of the first two methods the "aqueous wash" is regarded as most satisfactory, since the "vapour" method is liable to leave condensed residues which are extremely harmful to oil and will cause removal of inhibitors and violent sludging.

It may be of interest to describe the "aqueous washing" method. The turbine lubricating system is first completely drained of all oil, care being taken that no pockets of oil can remain undrained. The relay and power piston systems are then dismantled and cleaned by hand and all other easily accessible parts are also hand cleaned. The main tank is thoroughly cleaned and the main oil pump removed.

Bearing pedestal covers are removed and left off so that water vapour can escape and rusting will be avoided. Wherever possible bearing shells are also removed and the shaft

* South African Institution of Engineers, Johannesburg, December 11, 1947.

journals are protected by wrapping and coating with grease.

If an auxiliary oil pump is available, this is used to circulate the detergent solution, but care must be taken that the bearings of the pump are so designed that they will run satisfactorily while being lubricated only by the solution, the reason for this being that most auxiliary pumps are so arranged that their bearings are lubricated by the oil which is being pumped. A turbine-driven oil pump is not satisfactory from this point of view, since it runs at too high a speed and the bearings are not usually accessible for examination. It may therefore be found necessary to instal a small auxiliary pump temporarily.

Completion of the preparation of the system is made by placing weirs across the main oil return pipes so that these will run full.

A heating system of some kind is required in the main oil tank since the effectiveness of the washing depends on the temperature of the detergent fluid. A copper steam heating coil arranged inside the tank with an external drain forms a suitable heating element. The temperature obtainable should not be less than 180 deg. Fah. The detergent solution is then prepared and heated in the main tank. Caustic soda in a concentration of 5 oz per gallon may be used, but more effective cleaning is obtained by the use of one of the numerous cleaning agents that are obtainable.

In addition to the steam heating coil in the tank, a condensate supply should also be available so that after the detergent washing operation has been completed, the tank may be refilled with clean water and a further rinsing operation be carried out. The detergent washing should occupy from six to ten hours, depending on the condition of the lubricating system. After this period the system should be completely drained and the tank refilled with condensate, which is then circulated and serves to wash away any trace of the detergent which may remain. A colour test using phenolpthalene should first be made on the condensate, and the washing should be continued, using condensate until the condition of the washing water leaving the turbine shows exactly the same colour reaction as the fresh water entering the machine. To avoid stopping to drain and refill during the final rinsing process, a continual replacement of condensate may be adopted. The success of this operation depends to a large extent on speed, since aqueous washing will result in rusting if at any time parts which have been wet are left to come into contact with air. It is therefore necessary to organise the operation in such a way that the work is carried through without cessation from the first circulation of the detergent to the final filling with the new charge of oil. The flushing process with condensate is carried out at a steadily reduced temperature so that the final washing is carried out at approximately room temperature. After the completion of this operation the washing water is drained off and the new charge of oil is immediately placed in the system, which is then flushed with this oil. After this all portions of the set which had been removed prior to cleaning can be replaced and further flushing with a new charge of oil can immediately commence. As it is not possible completely to remove all water by draining, the new charge should be centrifuged at about 150 deg. Fah. to remove any remaining traces of water.

In conclusion, I would like to suggest that many turbine lubrication problems can be avoided by using the highest quality of oils and taking advantage of modern advances in the treatment of such oils. At the same time the greatest benefit can only be obtained by careful maintenance, and intelligent operation of a turbine plant. The fact that turbine oil is fully inhibited will not prevent sludging and breakdown if good conditions are not maintained. A regular programme of centrifuging or filtering to prevent accumulation of foreign matter in the system and regular draining to tap off water which may not be dealt with by filtering will go a long way to removing one of the main worries of the turbine operator.

Canadian Engineering Notes

Modern Frit Plant

Almost one year to the day after ground had been broken, Ferro Enamels (Canada), Ltd., commenced manufacturing porcelain enamel frit in a new plant at Oakville, Ontario, Canada, on April 1, 1947. In the factory, which is 220ft long and 66ft wide and of single-storey construction, emphasis has been placed on generous ceiling heights and ample finestration to provide bright and comfortable working conditions.

The lay-out of equipment provides for continuous flow from one end of the factory to the other, and a railway siding with loading platform running the entire length of the building permits five box-cars to be accommodated at one time. Raw materials are unloaded into a hopper set into the platform and feeding a bucket elevator, which, in turn, feeds either of two belt conveyors, which carry the materials to bulk storage bins. There are sixteen of these bins in two rows of eight, each bin having a capacity of approximately 50 tons.

Batches are weighed directly into a removable hopper set on a scale car, which runs on rails under the bins provided with transfer tracks and turntables and carries the weighted batch to a 50 cubic foot Ransome mixer. The weigh hopper is elevated by an electric hoist and discharged by means of gravity and an electric vibrator into the mixer. The mixed batch is discharged into a portable hopper at floor level. Smelting is carried out in a 40ft by 60ft bay with a 30ft roof. There is a travelling crane for transporting the mixed batch to the smelters and the fritted batch to the driers. The latest type of batch-type smelter, fired by oil and with automatic temperature control, is employed. There are at present three of these units, with provision for a fourth, giving a capacity of 18,000,000 lb of frit a year and a potential capacity of 24,000,000 lb.

The frit is dried on continuous gas-fired rotary driers which discharge it over Magni-Power permanent magnets on to vibratory feeds, where inspection is carried out before packing in multi-wall valve-type paper bags, 100 lb net weight. The dried frit is placed on pallets and transported by fork truck to the storage area, where the pallets are stored in three decks.

Modernisation of Paper Plants

The British Columbia Pulp and Paper Company, Ltd., Vancouver, B.C., is engaged on a big modernisation and development plan at its plants at Woodfibre and Port Alice, B.C. The work at Woodfibre will be completed this year and involves an outlay of over 2,500,000 dollars. The work at Port Alice is in its comparatively early stages. Woodfibre plant now has a daily capacity of 230 tons, and Port Alice, 200 tons.

To develop additional and more efficient water and power supply at Woodfibre, a new dam was built at Henrietta Lake, which is at the 2800ft level. To move materials to the site, 4 miles of road were driven into the mountains at H-Lake. This lake was tapped several years ago by driving a tunnel under it, allowing an effective drawdown with the new dam of about 85ft. The tunnel discharges into Cedar Creek, and the water is picked up by a diversion dam, flumed to a screen house and thence through woodstave and penstock to the power plant at the mill. The power house is of reinforced concrete construction and follows the conventional system, the boiler house and power house being built back-to-back. There are three boilers, each rated at 600 lb per square inch and 725 deg. Fah. The power plant on one floor has two Elliott steam turbines, each of 2000-kW capacity. The company is also erecting a 2000-kW Westinghouse condensing turbine, which was formerly in the old power plant. Provision has been made for a third Elliott steam set when the load warrants. Also installed on the same floor is a 2812-kVA Westinghouse generator. In addition to the work carried out at the power house, modernisation of the wood preparation plant was an item in the Woodfibre programme. The hydraulic barking plant has one of the first concrete log hauls to be built in British Columbia. The barking plant building is of steel internal column and roof and floor beam construction with concrete walls.

At the Port Alice plant the company has completed the erection of three chip storage bins, which are 80ft in height and 50ft in diameter, and which are of similar design to those at Woodfibre. The Port Alice power plant has been augmented by a 650 h.p. oil-fired marine boiler. Three acid storage tanks have been replaced and two new water tanks provided for fire protection. Old wooden roof trusses in the machine room have been replaced with steel trusses and a new ventilating system installed. Two new wood acid towers are being built to augment the seven existing towers and the old bronze pumps have been replaced with acid-resisting steel units. A Kamyr continuous chlorination unit has been installed to replace the present batch chlorination system, and changes will also be made in the method of chlorination feed.

The Late Martin Wolff

Former assistant engineer in the Bureau of Economics of the Canadian National Railways, later a member of the engineering department of the City of Westmount, Quebec, Mr. Martin Wolff died recently while on vacation at Hastings, Barbados, B.W.I. He was in his sixty-seventh year. Born in England, the son of Julius and Sarah Andrade Wolff, he was educated at Clifton College, Bristol, and later completed the Civil and Mechanical Engineering course at the City and Guilds of London Technical College. Coming to Canada in 1906, he became engaged in survey work with the Canadian Northern Railway and the National Transcontinental Railway.

Long Tractor Haul

Hauled by tractor train 325 miles over the ice of Great Slave Lake in Western Canada, 380,000 dollars' worth of heavy equipment for the Snare river power project in the North West Territories arrived twelve days after the start of the journey. The dam site, on Spruce Lake, is 95 miles northwest of Yellowknife. Four tractors hauled the 220 tons of equipment on twenty-five 10-ton sledges along the west side of Great Slave Lake from Hay River to Frank channel, and then inland 70 miles to the site. It was first moved by truck from the end of the railway at Grimshaw, Alberta. The tractor train was one of the largest and most valuable shipments ever made by tractor train across the ice of the lake. It included an 8000 h.p. turbine, generating equipment and other material too heavy to be flown in. The journey was under the direction of Mr. W. G. Stuart, resident engineer on the power project, who led the way in a "Snowmobile." Aerial observers made daily flights over the ground party, reporting their progress and helping to select the best route.

All-Welded Box Car

The Canadian Pacific Railway has placed in service Canada's first all-welded steel box car. Whether all cars will be built the same way will depend on the new car's performance under normal operating conditions. With its side-sheets welded by a submerged arc method, the new box car is expected to be slightly more water-tight than standard cars now in use, and to be somewhat cheaper to build in quantity. It weighs 45,000 lb, about 400 lb less than ordinary box cars, and has a capacity of 124,000 lb.

Atomic Energy Laboratory

Construction has been started on a new 300,000 dollar laboratory at Canada's atomic energy plant. The foundation has been completed and the project will be completed by early summer. Largest atomic energy plant outside of the United States, the establishment is the research centre for the entire British Commonwealth, and has a number of English physicists on its staff.

Industrial and Labour Notes

Steel Production and Allocation

In answering a question in Parliament on Thursday of last week, the Economic Secretary to the Treasury, Mr. Douglas Jay, announced an increase in this year's steel target. He said that, when it was fixed, the target of 14,000,000 ingot tons was thought to be barely attainable; but, thanks to the successful and strenuous efforts of all concerned, the target rate had in recent weeks been exceeded. Owing to seasonal factors, however, it was unlikely that the present rate could be maintained without interruption. There would be difficulties about raw materials, Mr. Jay continued, and there might be other limiting factors outside the control of the industry itself.

Mr. Jay went on to say that the Government intended to continue helping the industry in every way to maintain the present momentum, and, in view of the promising start and the imperative need for increasing supplies, it had been decided to raise the target for home steel production in 1948 to 14,500,000 tons. The current allocations were already being made with that increase in mind, but also with due regard to the uncertainties about imports. At the same time, Mr. Jay emphasised that, in view of the increasing demands from essential consuming industries, there was as yet no prospect of any great easement of the general shortage of steel.

Steel Production Costs

In a statement which accompanies the annual report of John Summers and Sons, Ltd., Mr. R. F. Summers has commented on the present cost of steel production. During last year, he points out, the price of coal was increased on two occasions and also 24 per cent was added to railway freight rates. There was a general increase in the price of all steel products in October, 1947, which went some way towards meeting those extra costs, and a further increase was made in January of this year, although then the price of steel sheets was not raised. The effect of coal and transport prices on steel, Mr. Summers observes, cannot be overemphasised.

Another disappointment, the statement says, has been the increase in the price of oil fuel. During the acute coal shortage the steel industry was urged to convert melting furnaces and other types of furnace from coal to oil firing, work on which many thousands of pounds of capital were spent, and now steel makers are faced with a handicap amounting to some shillings a ton by the rise in the price of oil. The ultimate recovery of this country, Mr. Summers continues, cannot take place until the inflationary tendency has been stopped and prices show a downward trend. Steel makers, he comments, are constantly endeavouring to improve production methods and reduce costs, but there is a limit to which they can go in that direction until the cost of State services such as coal, electricity, gas and transport can be reduced.

I.C.I., Ltd., and Trade Unions

In the course of his chairman's statement at the annual meeting of Imperial Chemical Industries, Ltd., held in London yesterday, Lord McGowan referred to the company's relations with the trade unions, which, he said, had been maintained on the basis of a frank understanding of the various problems. Discussions had taken place during the year with the unions in order to define more clearly negotiating procedure on questions of wages and conditions of employment, and to obtain a more complete understanding of the complementary functions which the I.C.I. works councils were designed to carry out.

Those discussions, Lord McGowan stated, culminated in an agreement setting out the negotiating procedure which would operate with the assistance of shop stewards elected by the members of various unions in the company's factories. In the agreement, the unions concerned had formally recognised the I.C.I. works council scheme and had also recognised the freedom of employees to associate themselves with the advisory and consultative functions of works councils. In order that negotiations under the newly established procedure might be conducted on a representative basis, Lord McGowan said that the company had given an undertaking that, although union membership was not a condition of employment, it would bring to the notice of its workers its view that they should be members of an appropriate union signatory to the agreement.

Later in his address, Lord McGowan spoke about working hours, which, he said, were now forty-four a week for day workers and an average of forty-two a week for those on continuous shifts. He was glad to report that the trade unions concerned were co-operating in measures designed to ensure the maintenance of the level of output prevailing prior to the reduction of hours, and its expansion where possible. He admitted, however, that it was difficult to assess the results owing to the incidence of various extraneous factors which had affected production in the period during which the shorter hours had been worked.

The Institute of Economic Engineering

As a result of the Urwick Committee's recommendations on training for management, the Institute of Economic Engineering has revised its syllabuses and examinations. The six specialist subjects selected to comprise the technical, as distinct from the management, content of the Institute's examinations are:—Pre-production planning; production planning and control; methods, motion and time study; determination of manufacturing cost standards; performance and cost control; and production incentives.

The common management subjects suggested in the Urwick report have been accepted as suitable to meet the educational requirements on the managerial side of the Institute examinations. The Institute, the address of which is 28, Victoria Street, London, S.W.1, proposes to issue shortly fuller details of its examinations.

"The Three Partners in Industry"

The National Union of Manufacturers has commented in the May issue of its monthly *Journal* on the undertaking which it gave, in company with other industrial organisations, to the Chancellor of the Exchequer on the pegging of prices and profits. For the first time, it says, the three principal partners in the economic life of the nation—the State, management and operatives—had a real chance for co-operative action in their common interests and for the national good. Industry has made the first move with the single, simple qualification that only circumstances which are not within its control should lead to a change of position.

But, the National Union asks, what of the other two partners? The least that industry could expect was an undertaking by the Government that coal, electricity, transport and anything else owned or controlled by it should not rise in cost above the present prices, and that every effort would be made by increased economy and efficiency to reduce them. On the trade union side, the *Journal* says, the position is even worse. Manufacturers regarded their action as a challenge when industry after industry agreed to subordinate its private advantage to the national good. All that has happened on the part of the unions, however, is that further wage claims have been coupled with demands for the statutory expropriation of more profits.

The view which the National Union of Manufacturers says it is compelled to take is that, unless there is quite soon a similar undertaking to limit prices on the part of the Government, and to peg wages on the part of the trade unions, the lead already given by industry will be meaningless and ineffective. The outcome of the present unhappy position, it is added, is that industry is left with an increasing burden of responsibility for the nation's industrial recovery. The private sector of industry—which is still responsible for 80 per cent of total production—faces decreasing control over its day-to-day operations to such an extent that it is not too much to say that private enterprise will soon have its back to the wall. With the best will in the world, the National Union observes, the employers cannot carry the whole burden alone.

Employment and Unemployment

Statistics issued by the Ministry of Labour on Wednesday last showed that at the end of the month the total working population of Great Britain was 20,357,000, a decline during the month of 12,000 men and 27,000 women. According to estimates since June, 1945, the total working populaton has fallen by 1,292,000, although it has increased by 607,000 since mid-1939.

Between mid-1939 and mid-1945 recruitment for the Forces, partly offset by substantial new intake from the non-industrial sections of the population reduced the numbers in civil employment by nearly 1,600,000. Between mid-1945 and the end of March last, however, there was a net increase of 2,517,000.

The report states that in the week ending April 3, 1948, there were about 30,000 operatives in the manufacturing industries on short time, losing 12¼ hours each on the average. On the other hand, however, some 720,000 operatives were working on an average six hours overtime. In the manufacturing industries there were 7,267,000 people employed in March of whom 2,890,000 were in the group classified as "metals and engineering." Of the 3,657,000 people employed in the basic industries in this country during March some 763,000 were engaged in the coal industry, 74,000 in other mining and quarrying work, 1,451,000 in transport and shipping, 1,063,000 in agriculture, 35,000 in fishing, and 271,000 in public utilities.

The number of insured persons registered as unemployed on March 15, 1948, was 299,405, as compared with 300,840 on April 12, 1948. In addition, there were on the registers at April 12th, 13,832 uninsured persons, including 1716 boys and girls under eighteen years of age who had not yet entered industry.

The Electrical Trades Union

The second annual delegate conference of the Electrical Trades Union was held at Great Yarmouth last week. An important item on the agenda was the presentation of the Executive Council's report, a document which surveys in considerable detail the activities of the union during the past twelve months.

In the section of the report dealing with policy, the union's views on the control of industry are set out. The report says that, although an aspect of nationalisation, the control of industry has much wider implications for the trade union movement, and the rules of the Electrical Trades Union make provision for the support of policies which will ultimately give the workers ownership and control of industry. What is meant by workers' control of industry, it is explained, is that the workers employed in an industry or a public service shall have some say in the management and control.

The demand for workers' control, the report continues, has become more widespread and general with the nationalisation of the mines, transport and the electricity supply industry. There is a great deal of disquiet in the trade union movement, however, at the appointments that have been made to the boards of nationalised industries, and the report comments that there is a feeling that "elderly civil servants and retired major-generals are not the best representatives that can be found for the newly nationalised industries."

French Engineering News

(From our French Correspondent)

Outlining technical progress in French mining since the liberation, Monsieur Chenin, engineer of the Houillères de Lorraine, said that the use of electrically driven belt conveyors presented difficulties and that the problems the installation of these belts create had certainly not been solved yet. The diesel engine had now largely replaced the compressed air motor. Electrification of French mines was going ahead. Electrical equipment was difficult to obtain and extremely costly, but it was replacing compressed air wherever possible. No progress had yet been made, however, in the use of electricity in mechanical hammers. The voltage used in the mines was 500V for machinery and 125V for lighting. Although there was still a long way to go, much work on the design and construction of electrical equipment was being carried out.

* * *

Speaking at a luncheon for the British Gauge and Tool Makers' Association, given by the directors of the Paris Fair, Mr. Gilbert T. Beach, secretary of the Association, said that British exhibitors were doing excellent business and were taking good orders. Unfortunately, there was little hope that the orders would be delivered because the French government would not grant import licences. He asked that the French should include a quota for machine tools from Britain adequate to the country's needs under the rehabilitation and rebuilding programme. French speakers made the same points as Mr. Beach. Mr. W. I. Combs, Second Secretary at the British Embassy, said that three years had elapsed since the end of the war and it would not be human to avoid expressing some disappointment over the fact that that period had not sufficed to bring about the free flow of trade hoped for as a quick successor to the end of hostilities.

* * *

At a conference given at the Sorbonne, Monsieur Lemaire, Director General of the S.N.C.F. admitted that French steam traction was too slow and that users were dissatisfied. He explained that the slowing down of speeds was due to economies. Speeds on the Paris-Lyons line would increase considerably as soon as the present electrification work was completed. It was hoped that work would be completed by 1952. The line to Dijon should be completed by 1950. Monsieur Lemaire said that the S.N.C.F. was often accused of using too much steel and thereby holding up other forms of reconstruction. He pointed out that in 1946 concrete was used whenever possible and said that in 1946 484,000 tons of steel were used and 510,000 tons of scrap were turned in by the railways.

* * *

Work on thermal electricity plant is going ahead in the north of France. At Harnes a new thermal plant is under construction, for which American equipment is being used. It is hoped that the plant will be ready to go into production during the second half of 1948. It will comprise two turbo-alternators of 52,500 kW each and four boilers fired by pulverised coal, to produce steam at 62kg per square centimetre. Extensive work is also being carried out on the extension of the Henin-Lietard No. 2 mining plant, where a generating station is being built. It will comprise two groups of 25,000kW each.

* * *

The possibility of transporting cement in wooden "containers" is under study. Cement production in France is increasing rapidly, and 500,000 tons monthly production is expected before the end of the year. There is an acute shortage of bags, however, and very little likelihood of sufficient raw material being imported to assure the production either of paper or textile bags. Wooden container transport is said to have many serious disadvantages, and the installation of silos for large users is believed to be the only way out. It will then be possible to transport the cement in bulk and store it where it is going to be used.

Notes and Memoranda

Rail and Road

BRITISH RAILWAY RECEIPTS.—The British Transport Commission has announced that the traffic receipts of British Railways for the four weeks ended April 18th totalled £25,486,000. In the same period London Transport traffic receipts were £4,497,000.

LONDON MIDLAND REGION APPOINTMENTS.—It is announced by the London Midland Region of British Railways that Mr. F. W. Abraham, M.I. Loco.E., A.M.Inst.T., Assistant Superintendent of Motive Power, has been appointed Motive Power Superintendent in succession to Mr. H. Rudgard, who became Chief Officer (Motive Power), Railway Executive, on January 1, 1948. Mr. I. C. Forsyth, M.I.Loco.E., Assistant Works Superintendent, Crewe Locomotive Works, since 1946, has now been appointed Works Manager at the same works.

THE CHINGHAI-SINKIANG ROAD.—The Chinghai-Sinkiang Road, which was completed last December, will shortly be open to traffic to provide a second overland link with the interior provinces. Hitherto the only road to Sinkiang has been the one from Shensi via the Kansu corridor. *China Newsweek* says that the new road, which is 810 miles long starts from Toutangho, 65 miles west of Sining, the provincial capital of Chinghai, and ends at Hungliukow (Changro) in Sinkiang. Construction work started in May, 1946, and the road is divided into two sections. The northern section, 140 miles in length, was built by the Sinkiang Highway Administration, and the southern section, 670 miles long from Monya to Toutangho, was built by the Chinghai Provincial Government.

TOTON MARSHALLING YARDS.—Work has begun at the Toton marshalling yards of the London Midland Region of British Railways on the extensive excavation and filling involved in the extension of the "Up" traffic yard, which is being modernised and mechanised in order to be able to deal with some 500 to 600 additional coal wagons daily. The total quantity of earth to be excavated and tipped amounts to about 400,000 cubic yards, the area involved being about 1¼ miles in length, parallel with the L.M.R. Erewash Valley main line on its up side, and covering in all approximately twenty-four acres. Included in the ground to be excavated is a small hill 50ft in height, which is being cut away by mechanical excavators. Spoil will be dumped and levelled to form the site on which additional arrival and sorting sidings, amounting to 27 miles of plain track and 5½ miles of points and crossings, will be laid. The diversion of a tributary of the River Erewash is also involved.

SIGNALLING ALTERATIONS AT HARROW-ON-THE-HILL.—Since February work has proceeded on the rearrangement of tracks and signalling north of Preston Road and at Harrow-on-the-Hill Station. It is pointed out by the London Transport Executive that under the original layout, delays to traffic were caused by the southbound Metropolitan Line fast trains having to cross both local lines north of Preston Road Station and also at the north and south junctions at Harrow-on-the-Hill Station. The removal of the flat crossing and the rearrangement of the fast lines to make them independent of the local tracks will result in improvements to both fast and local services. In addition, new signalling has been installed between Preston Road and Harrow North and a master signal cabin embodied in the new station buildings at Harrow-on-the-Hill controlling two subsidiary automatic cabins north and south of the station. To minimise interference with existing facilities the work has been carried out in stages. The sixth and final stage took place during the night of May 1st/2nd, when the existing signal cabins at Harrow-on-the-Hill and Harrow South, with all signalling controlled from them, were taken out of use and the new master cabin and signalling installation brought into operation.

Miscellanea

SCRAP FROM GERMANY.—A written reply by the Parliamentary Secretary to the Ministry of Supply states that, between January 1st and April 30th, about 167,000 tons of iron and steel scrap were imported from Germany. It is not possible, the reply says, to forecast how much will be delivered during the whole year.

DESIGN WEEK FOR MANCHESTER.—Arrangements are being made for "Manchester's Design Week," which is to be held from June 21st to 27th. The Council of Industrial Design is taking an active part in the organisation and particular attention will be paid during the week to plans for producing designs for exhibition at the 1951 Festival of Britain.

RADIO FREQUENCY CABLES.—The Committee on the Standardisation of Electrical Cables and Wires for Government Services has recently issued Specification No. 23, which deals with radio frequency cables used by the Services and other Government departments. Copies can be obtained from H.M. Stationery Office, price 1s. 3d.

DISPOSAL OF PLATING ROOM WASTES.—The research committee of the American Electroplaters' Society has initiated an investigation into the disposal of wastes from electroplating establishments. One of the most poisonous of all plating wastes is cyanide, and the investigation is aimed at developing methods of purifying waste waters from electroplating establishments prior to their discharge into streams.

UNIVERSITY GRANTS FOR TECHNOLOGICAL EDUCATION.—The University Grants Committee has appointed a sub-committee to advise on matters concerning technological education and research in the universities and to obtain liaison with the National Advisory Council on Education for Industry and Commerce, set up by the Ministry of Education. Dr. A. E. Trueman, F.R.S., will serve as chairman of the sub-committee.

EXHIBITION OF TYPEWRITER CASTINGS.—The first of a series of exhibitions arranged by John Harper and Co., Ltd., Willenhall, Staffs, for the benefit of its employees, is now in progress. It shows the range of castings which the firm is supplying to the British typewriter industry, and its purpose is to demonstrate how the firm's products contribute to the manufacture of machines of special significance in the export drive.

OVERSEAS SCIENTIFIC RELATIONS COMMITTEE.—The Lord President of the Council, acting on the advice of the Advisory Council on Scientific Policy, has approved the setting-up of an Inter-departmental Committee on Overseas Scientific Relations. Its function will be to consider and advise on questions of United Kingdom Government policy on matters of overseas scientific relations. Sir Edward Appleton, F.R.S., is chairman of the committee, the membership of which includes also the foreign secretary of the Royal Society, representatives of the British Council and the Conference of Research Associations, and two University scientists. The secretary of the committee is Mr. H. L. Verry, Overseas Liaison Division, D.S.I.R., 142, Piccadilly, W.1.

WHITAKER'S ALMANACK, 1948.—We have lately received a copy of "Whitaker's Almanack" for 1948, which, as a work of reference, fully maintains the high standard of usefulness and accuracy set by its predecessors. Many of its sections have been extended, including those dealing with Government and Municipal organisations. The finance and industry of this country are comprehensively reviewed, and the Dominion and foreign sections give the latest available particulars concerning political, trade and other matters of interest. In addition to this wealth of general and specialised information, the new volume includes, of course, the traditional astronomical section, with its tidal tables, meteorological observations, and its interesting historical calendar. The Almanack is published, as usual, by J. Whitaker and Sons, Ltd., 13, Bedford Square, London, W.C.1, at 12s. 6d. and 7s. 6d.

THE LATE DR. WILLIAM WILSON.—It is with regret that we have to record the death in Carolina of Dr. William Wilson, who was born in Preston and trained in Manchester and Cambridge. He played an important part in the development of the high-vacuum thermionic tube and radio-telegraphy, mostly in Canada and America. He was sixty-one years of age. He received his education at the Manchester Grammar School, and went on to the Manchester University to study radio-activity under the late Lord Rutherford. After gaining his M.Sc. degree he went up to Cambridge to continue his studies under the late Sir J. J. Thomson. He gained at the same time both the Langworthy Scholarship and the 1851 Exhibition Scholarship offered for the British Empire. He obtained his Cambridge D.Sc. degree, and about 1912 went out to Canada to take up the post of Lecturer in Physics in the University of Toronto. He joined the research staff of the Engineering Department of the Western Electric Company in 1914, and for twenty-eight years he did successful work on radio-transmission problems and long-distance radio-telephony, and also carried out research work on vacuum tubes and general research connected with radio-transmission problems. In 1942 he retired because of ill-health but recovered sufficiently to accept the post of Professor of Physics in the State College of North Carolina three years later.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Chemical Society

To-day, May 21st.—King's College, Newcastle-upon-Tyne, 1. "Modern Theories of the Mechanism of Drug Action," A. R. Todd. 5 p.m.

Friday, May 28th.—Trinity College, Dublin. "Absorption Spectra as Chemical Tools," A. E. Gillam. 7.45 p.m. Washington Singer Laboratories, Prince of Wales Road, Exeter. "Advances in Immunochemistry," M. Stacey. 4.30 p.m.

Incorporated Plant Engineers

Monday, May 31st.—Mines Department, The University, Leeds. "Steel," Mr. Ervine. 7.30 p.m.

Institute of Navigation

To-day, May 21st.—Royal Geographical Society, 1, Kensington Gore, S.W.7. "Meteorology in Aviation: Is It Obsolete?" Francis Chichester. 5.30 p.m.

Institute of Welding

Wednesday, May 26th.—The Connaught Rooms, Great Queen Street, W.C.1. Luncheon to mark the Foundation of the International Institute of Welding. 12.30 p.m.

Institution of Chemical Engineers

Wednesday, May 26th.—Geological Society, Burlington House, Piccadilly, W.1. Annual General Meeting. 5.30 p.m.

Institution of Electrical Engineers

To-day, May 21st.—MEASUREMENTS SECTION: Savoy Place, Victoria Embankment, W.C.2. "Great Personalities in the Fields of Electrical and Magnetic Measurements," J. T. Macgregor-Morris. 5.30 p.m.

Saturday, May 22nd.—N. MIDLAND STUDENTS' SECTION: City of Leeds Electricity Department Offices, Whitehall Road, Leeds, 1. Annual General Meeting and Films Afternoon. 2.30 p.m.

Wednesday, May 26th.—LONDON STUDENTS' SECTIONS: Savoy Place, Victoria Embankment, W.C.2. Annual General Meeting. 7 p.m.

Institution of Engineering Draughtsmen and Designers

Friday, May 28th.—Royal Society of Arts, John Adam Street, Adelphi, W.C.2. "Three-Dimensional Engineering Drawings," W. E. Walters. 7 p.m.

Institution of Locomotive Engineers

Friday, May 28th.—Dorchester Hotel, Park Lane, W.1. Reception and Luncheon. 12 noon.

Institution of Mechanical Engineers

Saturday, May 22nd.—LONDON GRADUATES' SECTION: Visit to Betteshanger Colliery, Deal. 1.30 p.m.

Saturday, May 29th.—MIDLAND BRANCH GRADUATES' SECTION: Shakespeare Memorial Theatre, Stratford-on-Avon. Annual Summer Meeting and Ladies' Afternoon. 2.30 p.m.

Institution of Structural Engineers

Thursday, May 27th.—11, Upper Belgrave Street, S.W.1. Annual General Meeting. 5.55 p.m.

Friday, May 28th.—MIDLAND COUNTIES BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham. "Some Impressions of a Tour Through Germany," J. D. Vaughan. 6 p.m.

Monday, May 31st.—MIDLAND COUNTIES BRANCH, GRADUATES' AND STUDENTS' SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham. "History of Structural Engineering," H. W. Coultas. 7 p.m.

Manchester Association of Engineers

Wednesday, May 26th.—Visit to The Whitecross Company, Ltd. 2.15 p.m.

Manchester Geological and Mining Society

Thursday, May 27th.—Visit to Rope Works of Glover Brothers (Mosley), Ltd. 12.45 p.m.

North Western Fuel Luncheon Club

Wednesday, May 26th.—The Engineers' Club, Albert Square, Manchester. "The Exploration For Oil in Great Britain," G. M. Lees. 12 noon.

Royal Aeronautical Society

Thursday, May 27th.—Institution of Civil Engineers, Great George Street, S.W.1. Thirty-sixth Wilbur Wright Memorial Lecture, A. Gouge. 6 p.m.

Royal Institution of Chartered Surveyors

Monday, May 31st.—12, Great George Street, S.W.1. Annual General Meeting. 5 p.m.

Women's Engineering Society

Monday, May 24th.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester. "Manchester Ship Canal," P. N. Reed. 6.30 p.m.

FESTIVAL OF BRITAIN, 1951.—The Lord President of the Council has announced that the council to supervise the Festival of Britain, 1951, has now been constituted under the chairmanship of General Lord Ismay. The council's function will be to supervise the Festival as a whole, responsibility for the detailed planning and arrangements resting on a number of constituent organisations with specialised knowledge and competence in the various fields to be covered.

Personal and Business

MR. E. H. BALL has been appointed a director of the Metropolitan-Vickers Electrical Company, Ltd.

SIR JOHNSTONE WRIGHT has been elected a director of British Insulated Callender's Cables, Ltd.

MR. ERIC G. YARROW and Mr. G. Sturrock Brown have been appointed directors of Yarrow and Co., Ltd.

THE COLONIAL OFFICE announces the appointment of Mr. Donald Wignall as assistant engineer, Public Works Department, Uganda.

MR. J. W. GARTON has been appointed chairman of Brown Bayley's Steel Works, Ltd., in succession to Mr. E. H. Armitage, who has resigned.

MR. W. LYONS, chairman and managing director of Jaguar Cars, Ltd., has been elected a vice-president of the Society of Motor Manufacturers and Traders, Ltd.

COLONEL R. B. EMERSON, M.Inst.T., lately Chief Commissioner of Railways in India, has been appointed deputy-chairman of Dowsett Engineering Construction, Ltd., and its associated companies.

MR. R. H. STEPHENSON has been re-elected chairman of the Dry Dock Owners and Repairers Central Council. Mr. G. S. Cromar, and Mr. E. L. Champness have been re-elected vice-chairmen.

BRITISH INSULATED CALLENDER'S CABLES, LTD., announces the retirement of Mr. Harry Hill from his position as manager of the Erith works. He joined the staff of Callender's Cable and Construction Company, Ltd., in 1906.

THE NORTH OF SCOTLAND HYDRO-ELECTRIC BOARD announces the following appointments: Mr. T. Lawrie, general manager; Mr. W. D. D. Fenton, secretary and commercial engineer, and Mr. H. W. Simpson, deputy secretary.

THE BRITISH CORPORATION REGISTER OF SHIPPING AND AIRCRAFT announces that Mr. James Turnbull, principal surveyor in London since 1937, will shortly be transferred to the head office, at Glasgow as Assistant Chief Surveyor. He will be succeeded as Principal Surveyor for the London area by Mr. Reginald Ibison, hitherto Principal Ship Surveyor to the British Corporation on the North-East Coast.

Contracts

THE HUNSLET ENGINE COMPANY, LTD., has received from the National Coal Board and from heavy industries, orders for fourteen of the 48½-ton "Austerity" saddle-tank locomotives, of which 377 were built during the war years.

THE UNITED PROVINCES OF INDIA GOVERNMENT has placed a contract with Vickers-Armstrongs, Ltd., for the supply of the cement-making machinery and electrical equipment for a factory near Markundi, which will have a daily capacity of 700 tons of cement. The approximate value of the order is £870,000. The cement from this plant will be used primarily for the construction of the Rihand Dam.

THE HARLAND ENGINEERING COMPANY, LTD., Alloa, Scotland, has been awarded a contract valued at £200,000 for the supply and installation of electrical pumping plant to the order of the Argentine Republic. The contract covers the equipment of a pumping station at Caballito, Buenos Aires, which forms part of a scheme developed by the Argentine Obras Sanitarias for augmenting the supply of water to that city. The pumps are to be of the Harland "Spyrobowl" multi-stage, borehole type, having an output of 15,400 g.p.m. each at a head of 208ft. The pumping station will house six units, one of which will act as a standby and each is to be driven by a Harland 1300 h.p., 6240V, synchronous induction motor.

Catalogues

BAKELITE, Ltd., 18, Grosvenor Gardens, S.W.1. Publication entitled "Bakelite Progress."

WELLINGTON TUBE WORKS, Ltd. Folder giving steel tube standard dimensions and weights.

FERRANTI, Ltd., Hollinwood, Lancashire. List of Ferranti hermetically sealed instruments.

MUREX, Ltd., Rainham, Essex. Leaflet on metal powders for welding electrode manufacture.

MUIRHEAD AND CO., Ltd., Beckenham, Kent. Catalogue of laboratory condensers and inductances.

HERBERT WIDDOWSON AND SONS, Ltd., Canal Street Works, Nottingham. Catalogue of used machine tools.

VISCO ENGINEERING COMPANY, Ltd., Stafford Road, Croydon. Catalogue No. 471 on Visco water cooling.

WOODS OF COLCHESTER, Ltd., Colchester, Essex. Current publications dealing with fans and fan equipment.

ALFRED HERBERT, Ltd., Coventry. Illustrated catalogue of Archdale milling, drilling and boring machines.

ABERDARE CABLES, Ltd., Aberdare, Glamorgan. Brochure describing the manufacture of Aberdare cables.

Launches and Trial Trips

LEINSTER, motor passenger vessel; built by Harland and Wolff, Ltd., for British and Irish Steam Packet Company, Ltd.; length 367ft, breadth 50ft, depth 19ft; gross tonnage 4000. Engines, two trunk type, two-cycle, airless injection Harland-B. and W. diesel, with ten cylinders 500mm bore by 900mm stroke. Trial trip, March 25th.

ANGOLA, twin-screw passenger and cargo vessel; built by R. and W. Hawthorn, Leslie and Co., Ltd., for Companhia Nacional de Navigacao; length 549ft 7½in, breadth 67ft, depth 44ft 3in; gross tonnage 12,800. Engines, Hawthorn-Doxford oil, with six cylinders 670mm bore by 2320mm combined stroke, developing 13,000 b.h.p. Launch, March 24th.

NIGERIAN, single-screw steam vessel; built by Furness Shipbuilding Company, Ltd., for United Africa Company, Ltd.; length 415ft, breadth 56ft, 6in, depth 37ft 2in; deadweight 8000 tons. Engines North Eastern reheat superheat triple-expansion with cylinders 23in, 38in, 65in bore by 45in stroke, supplied by George Clark, Ltd. Trial trip, April 2nd.

SIDI BEL ABBES, passenger and cargo steamer: built by Swan, Hunter and Wigham Richardson, Ltd., for Soci t G n rale de Transports Maritimes à Vapeur; length 402ft, breadth 53ft 6in, depth 27ft 3in; deadweight 1850 metric tons. Engines, Parsons' twin-screw steam turbines with gearing of the single-reduction, double helical type. Launch, April 22nd.

SOUDAN, twin-screw motorship; built by Barclay Curle and Co., Ltd., for the Peninsular and Oriental Steam Navigation Company; length 525ft, breadth, 67ft, depth 43ft; gross tonnage 10,700. Engines, two sets of Barclay Curle-Doxford opposed-piston solid injection, with six cylinders 670mm bore by 2320mm combined stroke, developing 13,600 b.h.p. Trial trip, March 31st.

SOMALI, twin-screw motorship; built by Barclay, Curle and Co., Ltd., for the Peninsular and Oriental Steam Navigation Company; length 525ft, breadth 67ft, depth 43ft; gross tonnage 10,700. Engines, two sets of Barclay Curle-Doxford opposed-piston solid injection, each with six cylinders 670mm bore by 2320mm, combined stroke, developing 13,600 b.h.p. Launch, April 22nd.

AURIS, single-screw diesel-electric tanker; built by R. and W. Hawthorn, Leslie and Co., Ltd., for the Anglo-Saxon Petroleum Company, Ltd.; length 482ft, breadth 59ft, depth 34ft 10in; deadweight 12,000 tons. Engines, four Hawthorn-Sulzer diesel, of the four-stroke cycle trunk piston type, supercharged by exhaust gas turbo blowers, with eight cylinders, developing 1100 b.h.p. Trial trip, April 16th and 17th.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of report	Title	Post free s.	d.
B.I.O.S.			
394	Technical Report on the Ruhr Coalfield: Volume III		10
	Appendix No. 13A: A Rotary Rock Tunnelling Machine ...	1	7
	Appendix No. 18: The Use of Large Mine Cars in the Ruhr ...		10
	Appendix No. 21: The Three-Cylinder Steam Winding Engine		
	These reports have been published separately by His Majesty's Stationery Office as Ministry of Fuel and Power publications and should be ordered by title.		
1188 (part I)	Preliminary Survey of the German Pump Industry: Centrifugal, Axial Flow, Self-Priming and Reciprocating Pumps, &c.	10	3
1417	Food Preservation with Special Reference to its Domestic Application	4	2
1451	Glass Jets: Interrogation of Bernhard Wempe: for Rayon Spinning	1	1
1468	The Production of Resistance Alloys at Isabellen-Hutte-Heusler A.G., Dillenberg, Germany...	1	1

Technical Information and Documents Unit, German Division, Board of Trade, 40, Cadogan Square, S.W.1, which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

A Seven-Day Journal

The Wilbur Wright Lecture

THE thirty-sixth Wilbur Wright Memorial Lecture was delivered last evening by Mr. Arthur Gouge at a meeting of the Royal Aeronautical Society held in London. The lecture dealt principally with the size of transport vehicles and its effect on operational economy. Mr. Gouge, in introducing his subject, said that in spite of the variance between aerial and other means of transport, he believed that if history was interpreted aright it should be able to guide us so that mistakes made by our forefathers could, as far as possible, be avoided. He then suggested that in nearly all forms of transport the frequency of operation was largely dependent on the journey time, and, considering air transport, drew the conclusion that if the air journey was one hour, the frequency of service should be one hour. The size of the machines required, the lecturer pointed out, would be settled by the volume of traffic. Later in his lecture, Mr. Gouge spoke of Atlantic air services, saying that at speeds of 350 to 400 miles an hour the average journey time could be reckoned as from nine to ten hours, which suggested a frequency of two to three aircraft a day by each operating company. He contemplated the provision of aircraft to carry from 200 to 300 passengers, and made the observation that all forms of transport had grown from small vehicles to the largest possible on any route under consideration, and invariably the largest unit proved itself to be the most efficient. Another aspect of long-range air travel problems to which the lecture drew attention was that in the interests of safety and using general engineering commonsense the journey should be made from point to point in order to avoid the hazard of intermediate landings and take-offs. Bearing in mind the range and payload involved, Mr. Gouge said that we must be prepared to build in the future much larger sizes of aircraft than were being constructed at present. In view of the size and cost of aerodromes, however, he thought there was some doubt as to whether aircraft much larger than the "Brabazon" could be considered.

The Grid Failures

THE two grid failures which occurred on Sunday last, May 23rd, were the subject of statements by Lord Citrine, the chairman of the British Electricity Authority, and Mr. J. Hacking, the deputy chairman. The breakdown occurred owing to a combination of unexpected circumstances. It is pointed out that there has been no similar breakdown since 1934, and it seems unlikely that there will be any repetition of unexpected heavy increases in loads combining with line faults to bring about a recurrence of such breakdowns. It is well known that it is the practice of central power stations to do much maintenance work and repair work during the summer, especially at week-ends. On Sunday last the total national capacity of the plant was 10,943,000kW, of which 4,383,000kW were out of action for one reason or another. On Sunday last there was a change in the weather. The Authority took both Air Ministry and long-range weather forecasts, but the difference between the Sunday noon temperature forecast and the actual temperature at 57 deg. and 48·5 deg. Fah., respectively was of about 10 deg. That difference affected the load in the London eastern and south-eastern areas by as much as 200,000kW. Plans had already been made to import electricity from other areas to the extent of about 90,000kW, but by shortly after noon the importation figure had risen to 190,000kW. Much of that current was coming through the King's Lynn–Norwich line, which was put out of service by a fault and caused other circuits to become overloaded and to trip out. The actual fault was on a conductor joint which burnt out and allowed the conductor to fall to the ground; actually, it was one of 1500 such joints which in 1938 had been scheduled for replacement by a more modern type. It became necessary as the frequency fell for the south-eastern generating plants to shut down; supply was reinstated early in the afternoon. At 8.54 p.m. a serious fault occurred on the Bedford–Luton section of the grid, which led ultimately to a widespread shut down in the eastern and south-eastern areas. Supplies were resumed at 9.30 p.m. and were completely restored by 10.40 p.m.

A British Paint Export Plan

ON Thursday, May 20th, at the annual luncheon of the Paint Manufacturers' and Allied Trades' Association, it was announced that 150 members of the Association, with factories in all parts of Great Britain, are putting into operation a new export plan. They will manufacture high-quality paints for the export market using common formulæ, standard colours and packing, which will be sold through a new co-operative marketing organisation styled Associated British Paints. The plan has the support of the Board of Trade, which has allocated special supplies of raw materials. Sir Patrick J. Hannon, the President of the National Union of Manufacturers, said that his organisation had watched with great interest the growth of one of its youngest and most virile affiliated trade bodies. The President of the Association, Mr. R. B. Jackson, said that the next stage in the operation of the new plan was to provide the machinery with which to carry it through. There would be a Technical Committee to decide and allocate the formulæ and colours for their paints, distempers and varnishes, and a Costing Committee to guide the Sales Committee on prices. The Sales Committee would have the task of appointing the agents and distributors abroad and along with the Publicity Committee it would design attractive labels for containers, colour charts and sales literature, with special appeal to overseas markets in various parts of the world. The Association would be fully recompensed if as a result of the plan the medium and smaller-sized manufacturers who could not efficiently carry on an export trade on their own account should, by means of this co-operative venture, be enabled to make some contribution to our export trade.

Public Transport in Northern Ireland

A MEMORANDUM accompanying the Transport Bill, which has been prepared by the Ministry of Commerce of Northern Ireland, explains the purpose of the Bill which is to give effect to the Government's plans for public transport. An Ulster Transport Authority consisting of not less than five and not more than ten members is to be established with general powers to carry goods and passengers by rail, road and inland waterway within Northern Ireland, and to provide shipping services from Northern Ireland in connection with such services and for allied purposes. A copy of the Authority's report is to be laid annually before each House of Parliament. As from a day to be appointed by the Ministry of Commerce, the undertakings of the Northern Ireland Road Transport Board and the Belfast and County Down Railway Company are to be transferred to the Authority, which will assume all the rights and liabilities of those undertakings. The Road Transport Board will be dissolved and provision has been made for the eventual winding up of the Belfast and County Down Railway Company. The terms of compensation are set forth in the Memorandum, as are the financial provisions. Provision is also made for the terms and conditions of employment of the staff, the pensions and compensation for displaced staff. A new Transport Tribunal will be constituted under the Bill. It will have the duty of settling, after interested persons have been heard, the charges for public transport, and thereafter to review such charges. The Tribunal will also settle the conditions which will attach to the services and facilities provided by such public transport undertakings and to give jurisdiction with respect to such services and facilities.

Fifth Conference of Tank Superintendents

IT is announced by the National Physical Laboratory that the Fifth International Conference of Ship Tank Superintendents will be held at the offices of the British Shipbuilding Research Association, 5, Chesterfield Gardens, Curzon Street, London, W.1. from Tuesday, September 14th, to Friday, September 17th. The Conference is sponsored by the Admiralty; the British Shipbuilding Research Association; John Brown and Co., Ltd., Clydebank; William Denny and Brothers, Ltd., Dumbarton; the National Physical Laboratory, Teddington; the Royal Aircraft Establishment, Farnborough; Saunders-Roe, Ltd., Isle of Wight; John I. Thornycroft and Co., Ltd., Southampton, and Vickers-Armstrongs, St. Albans. It will be recalled that such international tank conferences were held periodically before the war, and the initiative in reviving them has been taken by Sir Charles Darwin, the Director of the National Physical Laboratory. The organisation of the forthcoming Conference is in the hands of a Committee of Management, which has been drawn from the institutions and firms sponsoring the conference scheme. Before the war, it was usual to hold such conferences every other year. The number of items to be discussed has been limited this year in order to make good discussion possible. The subjects selected are: skin friction, the choice of a suitable Reynolds Number for model screw experiments, the use of turbulence-promoting devices in model experiments, and cavitation tunnel tests.

Inland Waterways New Divisions

IT is announced by the British Transport Commission that arrangements have been made by the Docks and Inland Waterways Executive whereby a further stage in the co-ordination of waterways has been reached. The number of waterway divisions has been reduced to four, exclusive of Scotland. The separate organisations which were inherited from the original owners have now ceased, and within each division the administration will be unified under a divisional waterways officer, who will be responsible to the Executive. The following are the new divisions:—North-eastern, comprising the former Aire and Calder (with Goole Docks), Calder and Hebble, Sheffield and South Yorkshire, and Trent Navigations and also a section of the former Grand Union Canal north of Leicester; divisional officer, Mr. H. B. Emley; headquarters, Leeds. North-western, comprising the former Leeds and Liverpool Canal, Weaver Navigation (including Weston Point Dock), and Staffordshire and Worcestershire Canal north of Autherley; divisional officer, Mr. C. M. Marsh; headquarters, Northwich, later at Liverpool. South-western, comprising the former Sharpness and Gloucester Canal (including Sharpness and Gloucester Docks), Severn Navigation, Worcestershire Canal south of Autherley, Birmingham Canal; Navigations west of Birmingham, and Stourbridge Canal; divisional officer, Mr. A. C. Lisle; headquarters, Gloucester. South-eastern, comprising the former Grand Union Canal (including Regent's Canal Dock), but excluding portion north of Leicester, Birmingham Canal Navigations east of Birmingham, and Oxford, Coventry, and Lee and Stort Navigations; divisional officer, Mr. C. Saywood; headquarters, London. It is also stated that the railway-owned canals will be integrated into these four divisions as they are transferred to the Docks and Inland Waterways Executive.

Remarkable Freight Locomotives: Pennsylvania Railroad

By E. C. POULTNEY, M.Inst.Loco.E.

No. I

TOWARDS the end of 1946 the writer contributed a series of articles to THE ENGINEER, reviewing the development of steam locomotive power on the Pennsylvania from 1899 to the present time.* Amongst the more recent locomotives mentioned were some specially designed for heavy, fast freight train operation, of which a number have been built at the railway company's Juniata shops at Altoona, Pa. The present article offers a more complete description of these remarkable engines and, in addition, gives some particulars of the results obtained during a series of tests carried out with one of these locomotives, No. 6175, on the locomotive testing plant at Altoona, thus supplementing the former brief reference made to these engines. In the preparation of this article the writer has received very considerable assistance from H. T. Cover, Chief of Motive Power, Pennsylvania Railroad, which is gratefully acknowledged.

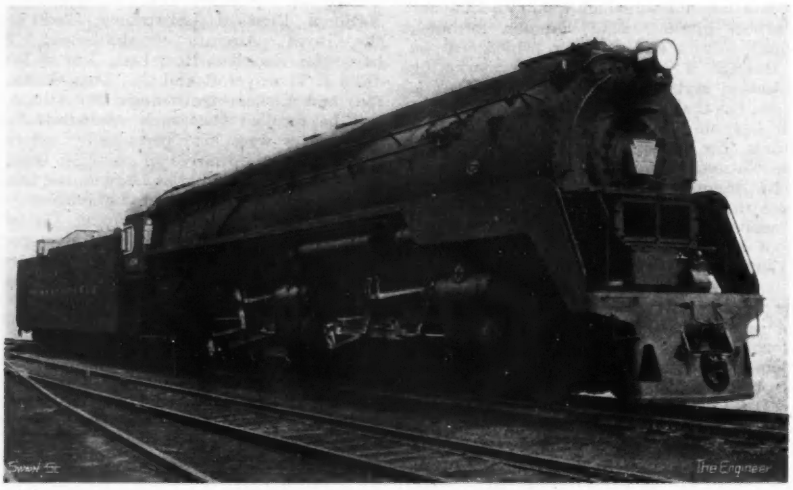


FIG. 1—"Q 2" LOCOMOTIVE

TABLE I.—*Principal Dimensions of Class "Q 2" Locomotives*

Cylinder, dia. and stroke (inches)—		
Front		19½×28
Rear		23½×29
Piston valves, dia. (inches)—		
Front		12
Rear		14
Wheels, dia. (inches)—		
Driving		69
Front truck		36
Rear truck		44
Boiler pressure (lb per square inch)		300
Heating surfaces (square feet)—		
Tubes and flues	6,000	Water contact
Firebox	725	Water contact
Evaporative	6,725	Water contact
Superheater (inside)	2,930	
Total	9,655	
Grate area (square feet)	121·7	
Weights (lb)—		
On drivers	393,000	
On front truck	96,050	
On trailing truck	130,050	
Engine total	619,100	
Tender, loaded	430,000	
Locomotive	1,049,100	
Tractive force, main, cylinders (lb)	100,800	
Booster	15,000	
Wheelbase, Engine (ft.-in.)	53—5½	
Wheelbase, locomotive (ft.-in.)	107—7½	

* THE ENGINEER November 8, 15 and 22, 1946.

These large locomotives designated class "Q 2," are of the four-cylinder, simple expansion type and have a leading four-wheeled truck followed by a group of four coupled wheels driven by a pair of cylinders at the leading end placed in the normal position. There then follows a further pair of cylinders of larger dimensions driving a set of six coupled wheels, and finally there is another four-wheeled truck supporting the firebox end of the boiler. These engines, therefore, have the 4–4–6–4 wheel plan; the arrangement will be made quite clear by a reference to the accompanying photograph and the diagram drawing. Table I gives principal dimensions.

The class "Q 2" engines may be said to constitute a development of a former class "Q 1" design, of which one locomotive was built previously in 1942 as an experiment at Altoona. This engine, also of the four-cylinder simple type, had, as the diagram, Fig. 3, shows, the cylinders differently arranged inasmuch as the hind pair were placed outside at the firebox end for driving a four-coupled set of wheels, while the front cylinders drove a six-coupled set, the idea of this cylinder arrangement being the shortening of the wheel base of the two sets of coupled wheels. However, the arrangement was not thought to be entirely satisfactory, due in part to rather lengthy steam and exhaust pipe connections to the rear cylinders and to the further difficulty of getting a good support for the slidebars. Further, placing the cylinders alongside the firebox was not an ideal plan. In designing the class "Q 2" reversion was therefore made to the arrangement adopted in the case of the four-cylinder 4–4–4–4 class "T 1" fast passenger locomotives, first built by the Baldwin Locomotive Works in 1942 from designs prepared in collaboration with the Pennsylvania Motive Power authorities, which engines had the leading and hind cylinder pairs placed ahead of the wheels which they drive.

It will be noted that the "Q 1," with 77in driving wheels, stood on a total wheelbase of 54ft 10in, of which that of the coupled wheels was 26ft 10in. Similar dimensions for the class "Q 2" with 69in wheels are 53ft 5½in, and 26ft 4½in, respectively. Some of the leading dimensions of the experimental "Q 1" class locomotive are given in Table II.

TABLE II.—*Principal Dimensions of Class "Q 1" Locomotive*

Cylinders, dia. and stroke (inches)—		
Front		23×28
Rear		19½×26
Piston valves, dia. (inches)—		
Front		12
Rear		10
Wheels, dia. (inches)—		
Driving		77
Front truck		36
Rear truck		46 and 50
Boiler pressure (lb per square inch)		300
Heating surfaces (square feet)—		
Tubes and flues	4,938	Water contact
Firebox	580	Water contact
Evaporative	5,518	Water contact
Superheater (inside)	2,290	
Total	7,808	
Grate area (square feet)	98·0	
Weights (lb)—		
On drivers	354,700	
On leading truck	89,900	
On trailing truck	148,900	
Engine, total	593,500	
Tender, loaded	434,370	
Locomotive	1,027,870	
Tractive force, main cylinders (lb)	81,793	
Booster	11,250	
Wheelbase, engine (ft.-in.)	54—10	
Wheelbase, locomotive	107—7	

It may be mentioned that this engine had piston valves actuated by Walschaerts motion.

THE BOILER AND SUPERHEATER

The class "Q 2" locomotives are notable for the very large boiler power provided,

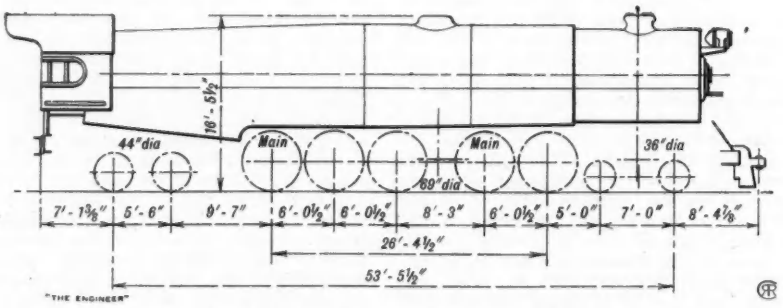


FIG. 2—DIAGRAM OF "Q 2" LOCOMOTIVE

shown by the steam production attained, which has reached a maximum rate of 134,476 lb of superheated steam per hour, corresponding to net evaporation of 137,479 lb of water per hour. The boiler barrel has a maximum diameter outside of 104in, and contains fifty-one 2¼in diameter tubes and 277 3½in flues for the type "E" superheater. Over the tube plates the length

is 21ft. The firebox is very large and is fitted with a combustion chamber extending forward in the barrel and having a length of $123^{27}/_{32}$in. There are nine sets of "Security" circulator tubes, six in the firebox supporting the arch and a further three in the combustion chamber. A drawing, reproduced in Fig. 4, shows a longitudinal section through the firebox from which the position of the circulator tubes can be seen and it also shows the position of some air induction tubes fixed in the two sides of the firebox of engine "6175," in connection with certain tests which will be referred to in a succeeding article.

The firebox with combustion chamber and the circulator tubes have a total of 703 square feet of heating surfaces based on the fire contact areas, and a net volume of 922 cubic feet. The grate area is 121·7 square feet. The net area of the tube and flue openings is 13·03 square feet. On account of the very long combustion chamber, provision for longitudinal expansion is made by inserting a corrugation in the connection between the combustion chamber and the firebox proper, which extends for about three-quarters of the circumference of the combustion chamber. Flannery flexible stay bolts are applied in the breaking zones of the firebox and the combustion chamber.

Both the firebox and combustion chamber are of welded construction. In common with Pennsylvania standards, the firebox is of the modified Belpaire type and the rear barrel course is specially formed to make the hip joints at the corners of the Belpaire pattern outer firebox shell, and so make a landing for the riveted joint between the barrel and firebox portions. Based on the fire contact surfaces, the distribution of the heating surfaces is shown in Table III.

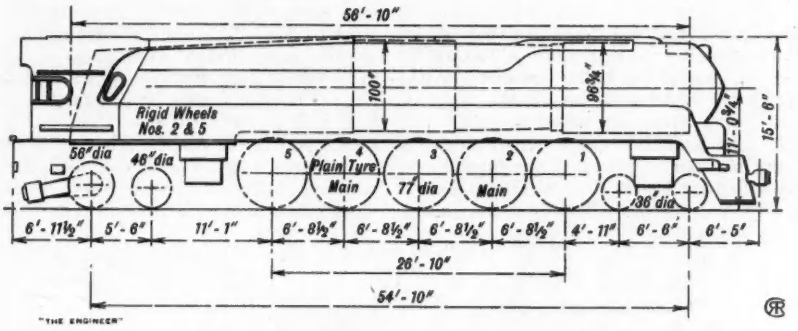


FIG. 3—DIAGRAM OF "Q 1" LOCOMOTIVE

The working steam pressure is 300 lb per square inch.

The feed water is supplied by a Worthington feed heater having a rated capacity of 14,400 gallons U.S. per hour, or 120,000 lb per hour, and in addition there is an injector of 15,500 gallons capacity equal to 129,000 lb per hour. Firing is by means of a standard type "H.T." stoker, and the grate has 17 per cent air openings.

There are double blast pipes, one for the front and one for the rear engines, and the two nozzles are of the six-point Kiesel type. The front one has an area of 24·6 square inches and that at the rear 33·3 square inches. Both nozzles discharge into a single lift pipe and chimney having an egg-shaped section and an area at the top of 6·33 square feet. There is a cross connection between the exhaust passages of the two engines. The drawing of the smokebox shows the blast pipe and chimney arrangement and also the deflector plate, which was removed when the tests later to be described were made. The removal of this deflector increased the gas passage area under the table plate from 9·0 to 13·6 square feet.

TABLE III—*Distribution of Heating Surfaces*

	Square feet
Tubes and flues	5470
Firebox, including circulators	703
Total evaporative	6173
Superheater	3624
Total	9797

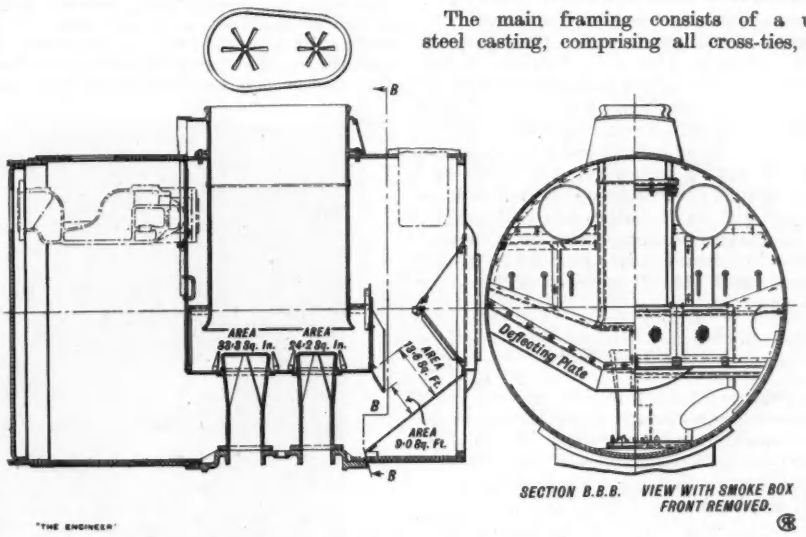


FIG. 5—SMOKE BOX, BLAST PIPE AND CHIMNEY ARRANGEMENT

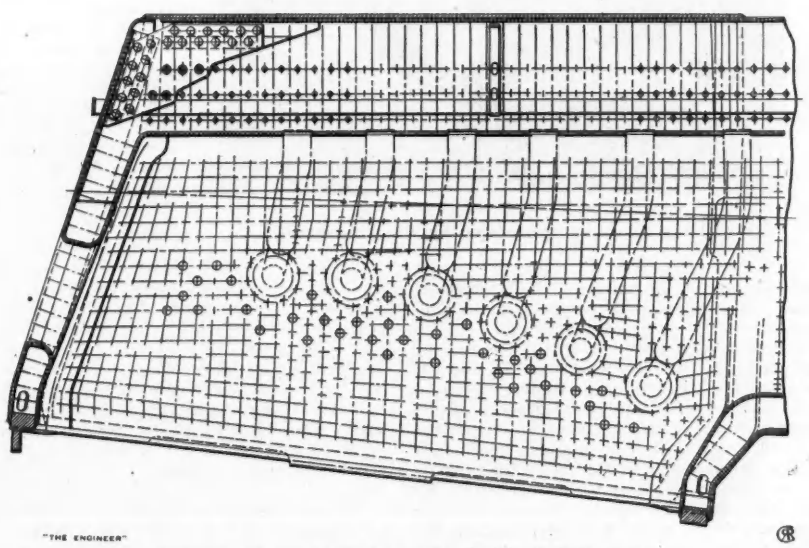


FIG. 4—LONGITUDINAL SECTION THROUGH FIREBOX

THE ENGINES AND MAIN FRAMING

The main framing consists of a unit steel casting, comprising all cross-ties, the four cylinders complete with valve chambers, and the cylinder hind covers. The leading pair of cylinders are placed in the normal position between the wheels of the leading four-wheeled truck, and the trailing pair are arranged between the trailing coupled wheels of the leading four-coupled group, and the leading pair of the hind group of six-coupled wheels. The connection between the frames and the hind cylinders is necked so as to enable the adjacent coupled wheels of the leading and trailing units to be as close together as possible, thus reducing the wheelbase of the coupled wheels. This wheelbase is, as already mentioned, 26ft $4\frac{1}{2}$in, which is reduced to an actual rigid wheelbase of 20ft 4in by making allowance for a certain amount of lateral movement for the axles. The rear drivers of each engine, that is Nos. 2 and 5 wheels, are the main drivers, and each of these has $\frac{1}{2}$in total lateral displacement. No. 1 wheels of the leading engine have $2\frac{1}{4}$in total lateral and No. 3 wheels, the leading pair of the rear engine, are allowed $\frac{1}{2}$in lateral movement, and in addition have a blind tyre. The No. 4 driver is allowed $1\frac{3}{8}$in lateral movement. All the driving-axle boxes are fitted with the Alco lateral motion control device. The connecting and coupling rods are equipped with float-

ing bushings for the crank pins. A spherical bush is fitted at No. 4 wheel, and the coupling rod bearings for wheels 1, 2, 3 and 5 have a radius on the outer bushing to accommodate operation on curves. The main crank pins have the usual type of floating bushes.

The cylinders are 19½in by 28in, and 23½in by 29in for the front and rear engines, respectively. The volume of the latter pair is 50 per cent greater than the leading pair, so that the power developed may be divided in the proportion of 40 and 60 per cent for the front and hind cylinders, respectively. The piston valves are 12in and 14in diameter, and the full gear valve travel is 8in, imparted by Walschaerts valve motions, which are controlled by an Alco power reverse gear. The coupled wheel centres are of the Boxpok pattern, and all the journal bearings of both the engine and the tender have Timken roller bearing boxes.

The steam supply to the engines is controlled by a multiple valve regulator housed in the superheater header and arranged on the superheated steam side of the header. The boiler steam pipe leading to the superheater has a cross section of 104 square inches. From the header the steam flows to each of the steam chests through pipes each having an area of 29·6 square inches. The area of the steam passages through the "E" type superheater totals 139 square inches. The port areas between the steam chests and the cylinders are 39 square inches and 49 square inches for the front and rear cylinders, respectively, and the areas through the valve bushes are respectively, 70·4 square inches and 84·5 square inches for steam inlet and 94·8 square inches and 115·2 square inches for exhaust.

Slipping Control

A feature of considerable interest fitted to these locomotives is a special device for automatically arresting the slipping of either set of driving wheels and restoring power to the slipping engine unit as soon as it has been slowed down to the speed of the non-slipping unit. To accomplish this, butterfly valves are fitted in each of the four steam pipe connections to the cylinders. These are controlled by a differential switch, which admits air to the valve operating cylinders of the slipping engine only. The differential switch is driven by small wheels running on the treads of one No. 2 and one No. 3 driving wheel. When the slip is arrested the air supply is shut off and the steam pressure in the steam pipes opens the butterfly valves, thus restoring power.

Lubrication and Other Details

An extensive system of pressure lubrication has been adopted, consisting of three Detroit mechanical lubricators, two on the left-hand side and one on the right. These supply lubrication to the cylinders and valves, frame shoes, boiler pads, radial buffer and spring rigging frame equaliser pins, the guides and also to the engine-truck centre pin. It may here be mentioned that the crosshead guides are of the multi-ledge pattern and that the piston rod crossheads are of the underhung type. The spring suspension comprises the normal type of overhung laminated springs and the spring rigging for the front unit is compensated with the front truck and that for the hind unit with the trailing truck. The Westinghouse air brake operates on the engine and tender, the compressor capacity being provided by two 8½in cross-compound air pumps fixed on brackets at the front of the engine.

Tractive Force

The rated tractive force for the main cylinders reaches the high figure of 100,800 lb at 85 per cent of the boiler pressure. With a weight of 393,000 lb on all the coupled wheels, this gives an adhesive factor of 3·83. The Franklin booster fitted to drive the trailing pair of wheels of the hind truck adds a further 15,000 lb available at starting and low speeds. The total maximum tractive force of the locomotive is therefore 115,800 lb.

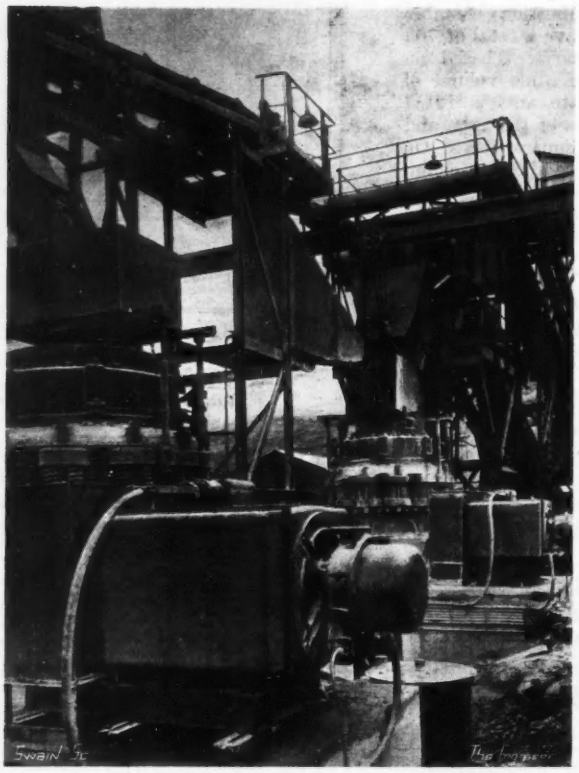
The Tender

The tender is of the rectangular tank type and has a cast steel underframe. There are two eight-wheeled trucks, also having cast steel frames. These steel castings, like the engine main frame casting, were manufactured by the General Steel Castings Company. The tank capacity is equal to 19,020 U.S. gallons, and there is space for 39·87 tons (2000 lb) of coal. When fully loaded these large tenders weigh 430,000 lb. In addition to the air brake there is also a hand brake and water pickup gear is fitted.

(To be continued)

Electricity in Scottish Quarries

AN interesting aspect of the hydro-electric schemes now being developed in the Highlands of Scotland is the use of electricity in the civil engineering and constructional work associated with these projects. Stone quarrying is one of the most important raw material feeders for this work, since it provides, *inter alia*, the aggregate used in building the dams. Our readers may therefore be interested in a brief account of the way in which electrical drives have been applied to some of the processes used in four Scottish quarries.



SECONDARY CONE CRUSHERS AT COIREGROGAIN

Although rock abounds in the Highlands, it is not always of suitable quality for forming the aggregate. It is often necessary, therefore, to discard the stone available in the immediate neighbourhood of a dam and to bring the material from a distant quarry where the stone is of the right quality. For some projects a new quarry has had to be opened. For Loch Sloy dam, in particular, the most suitable stone was found about 1¼ miles away, in the valley of the Coiregrogain stream, which flows down from the Ben Ime. The stone which is something between whinstone and granite, is grey in colour, flecked with close-knit white particles.

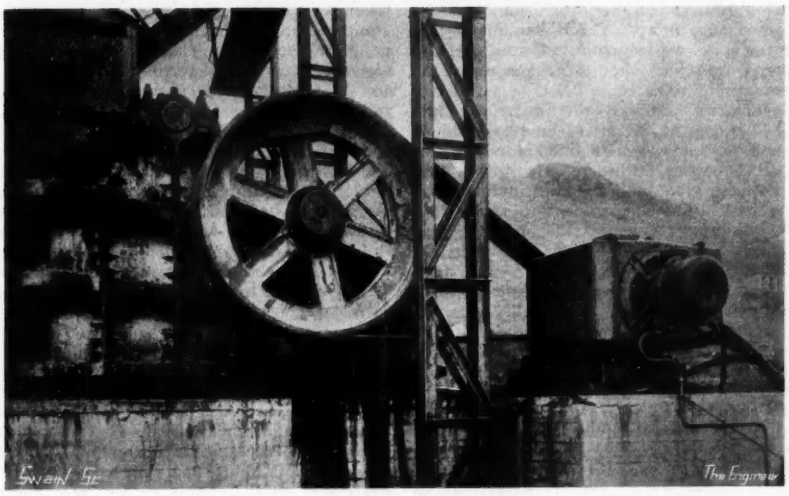
Before describing the installation at Coiregrogain it should be emphasised that quarry equipment, especially motors, must operate in the open under severe conditions of starting torque, and in many cases without skilled maintenance. The plant must, moreover, be proof both against abrasive dust and condensed moisture when the Highland mists descend. Its overload capacity must be high, and it must be flexible, since in many quarries re-arrangement of the plant constantly takes place as the quarry face is altered. Finally, to justify itself, in the eyes of the quarry owner, the equipment must be economical in first cost, maintenance and running charges.

Coiregrogain Quarry

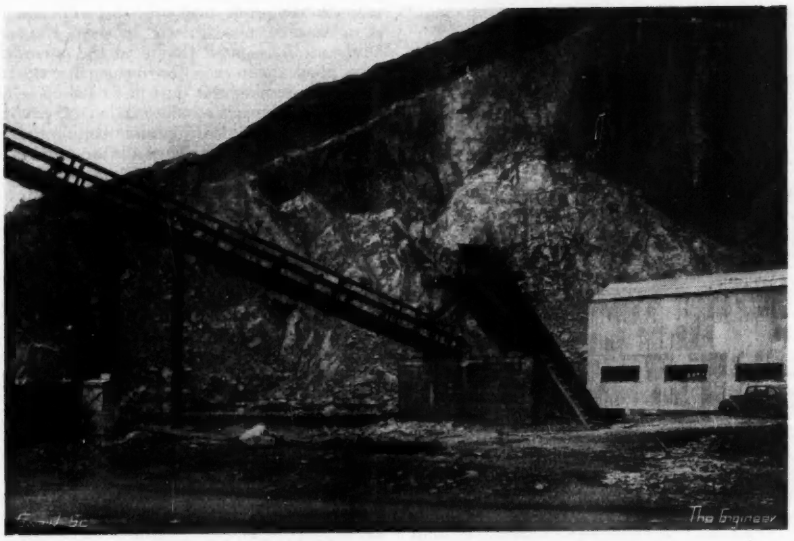
At the point selected for the quarry, there is little overburden of earth and the daily blasting operations bring falls of clean rock, which is collected by mechanical excavators and taken by dumpers to the primary crushers, some 80 yards away. Here a moving-band feeder, with variable speed control effected by cone pulleys, delivers the stone in a controlled flow to the jaws of the primary crusher. At Coiregrogain quarry two primary crushers are employed, each capable of receiving rocks 42in by 36in. These Hadfield crushers incorporate two manganese steel jaws, slightly inclined backwards from the vertical, and the rock falls between them as they open and close. The crusher is composed of massive castings, heavily ribbed, and forms an impressive sight as it slowly masticates the huge fragments of rock. There is a gantry and crane above the jaws, so that any extra large pieces of rock accidentally admitted can be removed by rope slings.

The drive to these machines must necessarily be as rugged as the crushers themselves. At Coiregrogain, as illustrated herewith, the drive

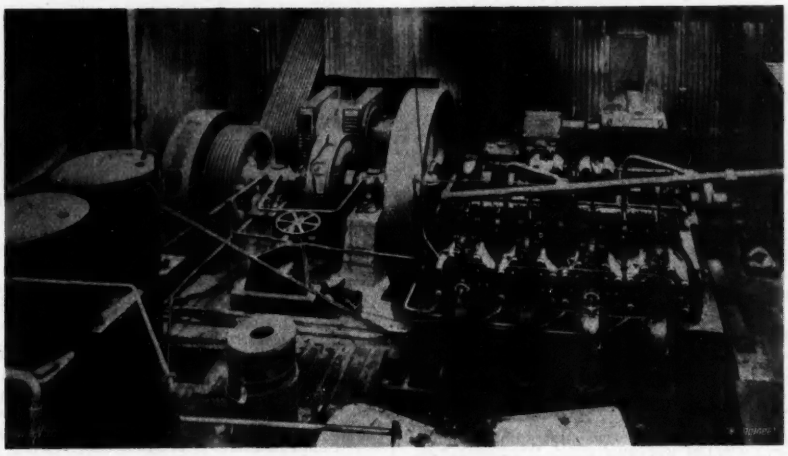
QUARRY PLANT IN SCOTLAND



MOTOR DRIVING PRIMARY CRUSHERS AT COIREGROGAIN



BELT DRIVEN CONVEYOR AT BONAWE QUARRY



250 H.P. ELECTRIC MOTOR AND 264 H.P. OIL ENGINE

is provided by an English Electric, weatherproof, 175 h.p., 725 r.p.m. closed-air-circuit slip-ring motor, operating at 440V, with liquid resistance speed control in the rotor circuit. Double coolers are fitted, so that the heavily abrasive dust—and grano-diorite dust must rank with the worst possible atmospheres in this respect—cannot enter the bearings or windings. The capacity for heavy starting and the ability to operate, unprotected, in all weathers, are the main requisites of these motors.

From the primary crusher the rock, now crushed to 8in pieces, is taken on a 30in-wide belt conveyor to the "grizzly," where any dirt is removed, before passing to the secondary crushers, of which there are two. These Nordberg 4in secondary cone crushers embody two massive cones, disposed vertically, one within the other, the rock being precipitated into the space between. The inner cone is caused to gyrate rapidly and opposes a spring-loaded crushing bowl. One of the accompanying illustrations shows the secondary crushers, which are driven through multiple vee-belts by weatherproof closed-air-circuit slip-ring motors again of 175 h.p., at 725 r.p.m.

At this stage, the stone is reduced to approximately 2½in fragments, which are taken by conveyor belt to the screens. Here there are successive wire meshes on rectangular steel frames, through which the fragments fall, and are sorted into 2½in, 1½in and ⅝in sizes, and then taken, again by conveyor, to steel hoppers, awaiting final transfer to the construction site. Pieces which are too large for the screens are taken back to the second of the two cone crushers to be processed once more.

CONVEYOR SYSTEM

The operations outlined above are typical of many Scottish quarries; but the means adopted at Coiregrogain for transporting the stone to the dam site are unique amongst them. To carry the quantity of aggregate needed for the civil engineering work on this scheme—it is estimated that at the peak of construction about 1500 tons of rock will be needed daily—an interesting form of belt conveyor with a capacity of 150 tons per hour has been installed between Coiregrogain quarry and the site of the dam. Rising over the brow of Ben Vane and then descending to the site, the conveyor is 1¼ miles long and is divided into fifteen separately driven sections, each delivering the aggregate forward to the next section. From the quarry site to the top of the brow over which the conveyor passes the total rise is 350ft. The length of each section depends on the gradient of the hillside and each section is driven by a separate motor, seven being of 25 h.p., three of 20 h.p., three others of 15 h.p., and two of 12½ h.p.

An overhead line operating at 11kV, running alongside the conveyor, provides the feed to the motors. There are three step-down transformers providing 400V, 3-phase current for the motor groups. To ensure that starting and stopping are carried out in an orderly fashion, the motors are started at five-second intervals, automatically, by time-delay relays. These are controlled via a pilot wire from the dam site end. An emergency stop button is provided at the quarry terminus. All the electrical equipment, including the necessary combined fuse-switch units for controlling the whole quarry installation was supplied by the English Electric Company, Ltd.

BONAWE QUARRY

A quarry of a different type, at Bonawe, provides another example of the benefits to be derived from electrification. The quarry is situated on a lonely part of the northern shore of Loch Etive, and is only accessible by boat, by ferry from the hamlet of Taynuilt, or by a rough, winding road from the north. Its products include granite chips of all sizes, for concrete making, sets for road surfacing, and granite for many other purposes.

The drive to primary and secondary crushers, the screens, and the remainder of the auxiliary plant was originally provided by two diesel engines. When J. and A. Gardner and Co., Ltd., decided to replace these engines by electric

drive, the first problem was that of supply, which the Grampian Electricity Supply Company solved by providing an 11-kV feeder spanning Loch Etive. Two steel pylons, 150ft high, were erected to carry the power across the loch, and into a three-panel type OLD (oil circuit breaker in cubicle) switchboard with overload and earth-leakage protection. There are two switches and an isolator, one switch being for the incoming feeder and the other supplying two transformers, one of 1000kVA and the other of 500kVA. Distribution throughout the quarry is carried out by means of English Electric CFS gear.

One of the photographs reproduced herewith shows a section of the 30in belt conveyor which carries material from the primary crusher across the railway track in the foreground to the crusher house. A totally enclosed, wind-cooled, weatherproof, squirrel-cage motor of 15 h.p. at 725 r.p.m. drives this section of the conveyor.

Two interesting aspects of this installation deserve mention. The first is the marked contrast between the size of the louvre-ventilated slip-ring motor, and of the original diesel engine installation as illustrated herewith. The 250 h.p., 440-volt, 725 r.p.m. drip-proof motor is housed in a small corner of the engine-room and drives the original line shafting by means of a vee-belt drive. Another motor of 60 h.p. is installed to drive a compressor for the pneumatic drills used on the quarry face.

The second interesting point is that the English Electric Company was asked, as part of this electrification contract, to install electric light and domestic services in the houses occupied by the quarry workers. There are two blocks of flats adjacent to the quarry, and each flat has electric light and provision for an electric cooker. Wiring and outlet facilities for all domestic purposes are also provided. Some ninety-six dwellings, together with a small cinema, a public hall and a shop have all been equipped in this way. Thus, not only has the electrification of the quarry added efficiency to the main purpose for its existence—the quarrying and processing of granite—but it has also enabled the owners to provide an isolated community with necessary amenities demanded by modern standards of living.

Another Scottish quarry where the same company was able to provide the whole of the electrical equipment, of a kind suitable for the arduous conditions in such establishments, is that of Messrs. Bell Brothers at Newburgh—this time on the east side of Scotland, in the county of Fife.

Newburgh is one of the largest quarries in Scotland and is engaged in the production of whin chips of all sizes. A large rock face is being quarried and, in effect, a hill some 200ft high is being eaten away over a period of years.

In this installation each of the Broadbent primary crushers is individually driven by a 100 h.p., 725 r.p.m., closed-air-circuit, slip-ring motor. A neat arrangement of CFS gear is installed at a central station to allow each motor in the quarry to be properly protected and controlled; emergency "stop" buttons are fitted alongside the motors, but the starting and protection is carried out centrally which simplifies maintenance and the problems involved in future extensions.

Shierglass Limestone Quarry

In the heart of the Highlands, at Shierglass, near the famous pass of Killiecrankie, is a new limestone quarry where the complete electrical equipment was provided by the English Electric Company.

At Shierglass the lime is taken from the quarry face by dumpers to the 36in by 24in primary crushers, which reduce the rock to approximately 4in pieces. These crushers are driven by 100 h.p. totally enclosed motors. A conveyor, also driven by an individual electric motor, then carries the lime rock to gearless, gyratory cone crushers, which break the material down to 1½in, ¾in or ½in sizes as required. These crushers are driven through vee belts by 40 h.p., totally enclosed, vertically mounted motors.

From the crusher a further conveyor carries the crushed material to the screens, which are situated at the top of a corrugated iron building, and from here the rejected material—that is, pieces of rock too large for the largest screen—is returned by another conveyor to be crushed once more. The remainder of the limestone chips are precipitated into vertical hoppers, from which they are taken away by lorry when required.

This quarry provides an important by-product besides the output of limestone chips, inasmuch as some of the lime is pulverised by a ball pulveriser, for use in agriculture. This machine comprises a horizontal cylinder of steel, about 6ft in diameter and some 20ft long, containing 7 tons of steel balls among which the limestone chippings are crushed to powder. The drive is by a 100 h.p. motor, and here the enclosure problem is especially acute as the very fine, highly abrasive dust produced by the pulverisers would rapidly ruin a motor not adequately protected in this respect. The pulverised lime is then blown to a special hopper by a fan driven by a 65 h.p. motor.

The electrical arrangements at this quarry centre on a neat intake room where the 440-volt supply from the Grampian Electricity Supply Company is distributed by CFS switchgear to all parts of the installation.

On all the quarry installations mentioned in this article the cabling and erection work was carried out by James Kirkpatrick and Sons, Ltd. The quarry plant at Coiregrogain was designed and is operated by Keir and Cawder, Ltd., who supplied the information for our description of the mechanical equipment.

The Royal Society's Conversazione

Fellows of the Royal Society and their guests met at the Royal Society's Conversazione, held at Burlington House, on Thursday of last week, May 20th. Some thirty exhibits were displayed to illustrate a wide range of scientific research. The President, Sir Robert Robinson, received the guests during the evening.

Progress made recently in microscopy of the living cell was well demonstrated by the exhibit of the National Institute for Medical Research and by a film shown by Cooke, Troughton and Simms, Ltd., made by the phase-contrast microscope. The phase-contrast microscope presents considerable advantages for such a study and with the technique evolved of taking successive photographs at intervals of some few seconds and projecting the resulting film at the usual speed, the growth and division of living cells are shown in a vivid manner.

The Cavendish Laboratory, Cambridge, had amongst its exhibits apparatus which can measure and record automatically noise powers of the order of 10^{-16}W. This apparatus has been devised in connection with the observation of radio-frequency radiation from the sun and stars. For reasons of stability and accuracy the receiver is used only to indicate equality between the incoming noise power and a locally generated power. A waveform characteristic of the misalignment between the two powers is produced at the receiver output, which is used to adjust the local noise source towards equality. Feedback through a non-linear resistance gives the equipment a rapid response to sudden input changes, while giving a relatively fluctuation-free output, under conditions of steady input.

Amongst several exhibits of the National Physical Laboratory, the Metrology Division demonstrated length measurement by interferometry. In the method shown the lengths of engineers' block gauges up to 300mm (12in) are directly measured with a Kosters gauge interferometer, which is an adaptation of the Twyman and Green modification of the Michelson interferometer. A hot-cathode, liquid-air-cooled krypton lamp is used as the source of standard wavelengths. An accuracy of about 0·025μ (1×10^{-6}in) is achieved on 300mm gauges, provided due precautions are taken in control and measurement of gauge temperature and in measuring atmospheric temperature, pressure and composition. A thermocouple is used in association with a standard mercury thermometer to measure gauge temperature. Thermal expansion coefficients of gauges are determined at 20 deg. Cent. to ±½ per cent over a temperature range of only 1 deg. Cent.

An ultrasonic memory system for an electronic digital computing machine was shown by the University Mathematical Laboratory, Cambridge. The exhibit consists of units developed for a high speed electronic calculating machine, known as the EDSAC (electronic delay storage automatic calculator), which is at present being built at Cambridge. Numbers are represented in binary form by trains of pulses each of length 1μ/sec. The pulses are passed in the form of ultrasonic waves into a column of mercury about 4in long. When they reach the end of the column they are reconverted into electric pulses and after amplification and shaping are routed back to the input. They thus circulate round indefinitely and are available when required. The exhibit also shows how the operation of adding can be accomplished by electronic means. The pulses pass through an adding unit during each circulation and when a button is pressed one digit is added to the number circulating in the delay unit. Alternatively, it may be arranged that one digit is added automatically at each circulation.

A remarkable electronic stop-clock, which can measure a time interval of up to twelve seconds to an accuracy of better than $^{1}/_{100}$ of a second was shown by the Explosives Division of Imperial Chemical Industries, Ltd. This clock is in use for measuring the time between pressing the button to set off a detonator and the actual detonation of a charge. A novel mechanical counter totals quarter-cycles of a standard oscillator within the interval defined by two events operating a gating circuit. The counter is a special form of d.c. polarised split phase a.c. motor by Scophony. The phases are direct-coupled to two inverters operated in quadrature by the standard oscillator. The hand geared to the motor thus moves discontinuously four steps per cycle, being locked between steps. As demonstrated, timing is by steps of 1·4 milli-seconds. A slight modification gives a random pulse counter with a discrimination of 0·8 milli-seconds.

Exhibits in connection with nuclear physics included a full-sized model of a 16MeV betatron, weighing only 17cwt and taking 80kVA at 50 cycles. The weight, kVA and size are low because its orbit space has been made narrow, and all other magnetic fields, including the accelerating field, are confined to iron. The original of this model is now installed at the Clarendon Laboratory at Oxford. Electrons are accelerated by continuous rotation in a narrow glass ring. During acceleration the electrons rotate more than 16,000,000 times, travelling more than 900 miles in the process. They do this in $^{5}/_{1000}$ of a second and at their fastest attain a speed within 0·05 per cent of that of light. By directing the electrons on to a target of dense material highly energetic 16MeV gamma rays are generated.

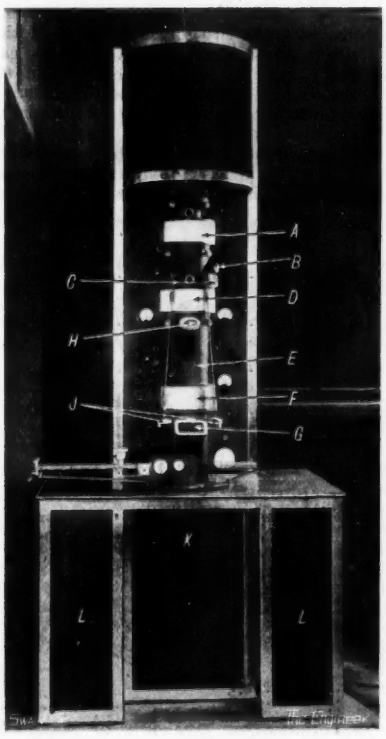
Institute of British Foundrymen.—The forty-fifth annual conference of the Institute of British Foundrymen is to take place in London from June 8th to 11th. The headquarters will be at the Café Royal, Regent Street, W.1, and technical sessions will be held there during the mornings of June 9th and 10th. The first of these, on June 9th, will be the annual general meeting, and following the official business and the presentation of awards, Mr. R. B. Templeton will deliver his presidential address. This is to be followed by the Edward Williams lecture, which will be given by Dr. H. Schwartz on "Some Solved and Unsolved Problems in the Metallurgy of Blackheart Malleable." The afternoon of June 9th will be given up to another technical session, but in the afternoon of June 10th visits will be made to various works in and around London. The whole day on June 11th will be taken up with visits to works. The Institute's annual dinner will be held at the Café Royal on Wednesday, June 9th.

Experimental Electron Microscope

THE electron microscope described in this article is an experimental model designed and constructed in the laboratories of the Plessey Company, Ltd., Ilford, Essex. Using this instrument, which was exhibited for the first time at the Physical Society's Exhibition in London last month, suitable specimens can be directly viewed at magnifications up to 20,000 diameters, and the images can be photographically enlarged by a factor of ten.

As illustrated herewith, the microscope proper consists of a cylindrical column about 4ft high by 6in in diameter, which must be maintained during operation at a pressure of about 10^{-4}mm of mercury to allow passage of the electron beam. The column is made up of seven major units, namely, the electron gun, condenser lens, specimen chamber, objective lens, intermediate chamber, projector lens and viewing chamber. At the top of the column is the electron gun, the high-voltage parts of which are protected from possible corona discharge by a highly polished shield. A small hairpin-shaped tungsten filament acts as the electron source, and from this the electrons are accelerated to 50kV by an apertured anode, through which they pass to the condenser lens A, and thence to the specimen. The function of the gun-condenser assembly is to provide at the specimen a supply of electrons of the desired velocity, intensity and convergence.

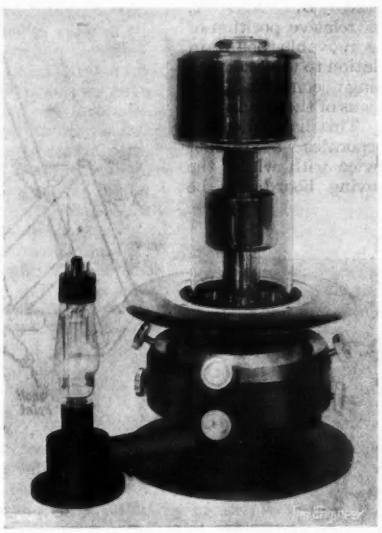
As it is essential that the electron beam be accurately aligned with the optical axis of the instrument, provision is made to control both the direction and position of the beam without disturbing the vacuum conditions. The pre-aligned anode-cathode assembly is mounted on a spherical seat, which provides



GENERAL VIEW OF ELECTRON MICROSCOPE

angular beam adjustment through the agency of the upper set of three adjusting screws shown in the accompanying view of the electron gun assembly. A plane seat immediately below permits horizontal traversing of the entire gun by adjustment of the lower set of three screws. The adjustable members are vacuum sealed to the main flange by a metallic bellows.

Referring to the general view of the electron microscope, the condenser lens A consists of an iron-shrouded bobbin, wound with a suitable number of turns, a central cylindrical hole permitting passage of the electron beam. The magnetic circuit is broken by a brass separator,



ELECTRON GUN ASSEMBLY

so that when current is passed through the windings a magnetic field is set up which is symmetrical about the axis and acts on the electron beam in a manner analogous to the action of a glass lens on a light beam.

The specimen chamber B houses mechanisms for inserting, seating and traversing the specimen. As it is undesirable to raise the pressure of the entire column to atmospheric when changing specimens, an airlock is fitted which reduces to approximately two minutes the time necessary to effect the change. Specimens are mounted in various ways on a copper grid of 200 meshes per inch. This grid is contained within a cartridge which is lowered into a tapered seat in the traversing stage through a system of levers, operated from outside the vacuum through suitable seals. Various portions of the grid may be shifted into the field of view by fine-thread screws operated through worm and worm-wheel reduction gearboxes C, one complete revolution of the specimen control wheel resulting in a movement of 0·001in of the specimen. Two such control units operating at 90 deg. to each other permit a complete coverage of the grid. To align the microscope provision is made for moving the top flange of the specimen chamber in a horizontal plane.

The objective lens D is of somewhat similar construction to the condenser lens. It is, however, provided with a removable pole-piece assembly, which focuses an image on the intermediate screen at a magnification of some 100 diameters; the pole-pieces are of special design and are lapped with great precision. The intermediate chamber E is provided with a movable top flange similar to that on the specimen chamber, and is fitted with a viewing port through which the intermediate image may be observed. As the beam is most affected at this stage by stray magnetic fields which would seriously affect the performance of the instrument, mu-metal screening is fitted inside the entire length of the unit. A small aperture in the centre of the intermediate screen permits a selected portion of the beam to pass through to the projector lens F, which resembles the objective lens except for the design of the pole-piece assembly, which produces a final image of up to 20,000 diameters.

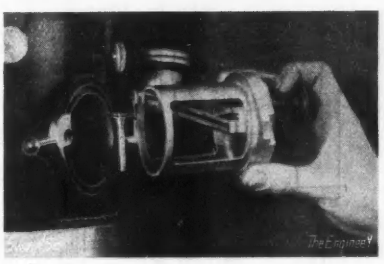
For the final viewing stage there is a port G in the viewing chamber which contains both the final viewing screen and the photographic equipment. The screen is mounted directly on the camera shutter, which when raised permits the image to impinge on the photographic plate below. The camera takes a 10in by 2in plate, which is inserted through an airlock similar in principle to that of the specimen chamber; five 2in by 2in exposures may be taken on one plate.

Unit-to-unit vacuum sealing is effected by neoprene gaskets seated in circular grooves, partially compressed by a mating projection of vee-shaped cross section. A similar seal is employed in all iron lens bobbins, which enables the windings to be placed outside the vacuum. This method of jointing, in addition to providing an excellent vacuum seal, allows the faces of mating parts to butt together, forming the very rigid construction which is essential because 0·001in movement of the specimen results in 20in movement of the final image at 20,000 diameters.

Because of its demountable construction, the column must be continuously evacuated during operation, and for this purpose an oil diffusion pump is used, backed off by a rotary pump housed in the pumping compartment K, formed by the central panel of the "desk." Pressures in the column are indicated by a Pirani vacuum gauge. The gauge head and exhaust manifold are shown on the left of the photograph of the electron gun assembly reproduced herewith.

All the magnetic lenses are fed from electronically stabilised power supplies with their currents controlled from the front panel. The h.t. potential of 50kV is obtained from a radio frequency operated supply situated in a chamber immediately behind the gun. Compartments L, L below the "desk" enclose the power packs.

To operate the instrument, a specimen is prepared on a copper grid and secured in the specimen cartridge which is attached to the loading mechanism and is replaced in the airlock as illustrated herewith. The airlock is rough pumped until the pressure is sufficiently low to warrant its being opened to the main vacuum system. The specimen cartridge is now lowered, by means of the external control, into its tapered seat, and the microscope is ready for operation. The power supplies are



SPECIMEN HOLDER

switched on, and after obtaining suitable illumination with the aid of the condenser control, a magnified image of the specimen grid appears on the intermediate screen, which is viewed through the port H. One of the grid apertures containing a portion of the specimen is shifted to a position over the intermediate screen aperture with the aid of the specimen controls J. The portion of the intermediate image over the aperture is passed through the projector lens and appears on the final viewing screen. Focusing is effected by controlling the objective lens current, whilst the desired magnification, independent of focusing, may be obtained by operating the projector control. The control knobs for the condenser objective and projector adjustments are grouped on the left-hand side of the instrument and control panel. A micrograph can be taken immediately by raising the shutter for the appropriate exposure time.

A Draughting Machine for Isometric Projection

WE recently attended a demonstration of a new instrument with which draughtsmen can quickly and accurately produce isometric drawings from plans and elevations. This machine, called the "Perspector 'A'," is a product of Isometric Projections, Ltd., The Green, Broad Street, Newport Pagnall, Bucks.

The "Perspector" is made to very close precision limits to incorporate accuracy with almost frictionless operation and in handling the instrument we found it very light to use, its operation being particularly smooth. Our engraving, Fig. 1, shows the general arrangement of the instrument, which approximates in size to a "Double Elephant" drawing board. It can be used on an ordinary table, as it is necessary only to ensure that the instrument is level to avoid uncontrolled swinging of the tracer arm. The "Perspector" has been designed to draw accurate ellipses without the laborious plotting which is inevitable by normal methods, and with this instrument the draughtsman locates precisely one drawing board in relation to the other so that the foreshortening required in isometric drawing can be made. In our illustrations, Figs. 3 and 4, the result obtained from an ordinary machine drawing used in conjunction with the "Perspector" can be seen.

The instrument consists primarily of a substantial underframe of welded construction, supporting a fixed board A and a moving board B, Fig. 2, the relative position of the movable board in relation to the fixed one being controlled by means of the handwheel C. This handwheel incorporates a ratchet device with which the moving board can be traversed in small regular increments to facilitate the drawing of screw threads, annular rings, &c. A rearwards extension of the underframe supports in ball bearings the central pivoting point of the linkage. This linkage has been designed to give an overall reduction of 1 to 2 in the north-south plane and a further reduction of 1 to 0·577 in the east-west or transverse plane.

The principle on which the machine is designed is based upon compounding the movements of two pantographs, one of which reproduces at the pencil point the movement of the tracer point D in a north-south direction and the other in the east-west direction. Through a secondary link X the movement of these two pantographs are compounded. The pencil assembly is suspended from a spider H carried above the compound pantograph axis on two steel guides, E and F. One of these guides restricts the movement of one of the pantographs in the north-south direction and the other the movement of the second pantograph in an east-west direction.

When tracing a circle from the master drawing on the fixed board A an ellipse of true isometric proportions is reproduced on the board B, the major and minor axes of the ellipse being represented by the two guides E and F. Motion to these is transmitted through the roller carriages G connected one to each part of the compound pantograph, and to a spider H above, which carries the drawing point assembly illustrated in Fig. 5.

In this assembly the pencil is held in a collett, which is easily released by undoing a small knurled nut. The lead can then be sharpened on a special sharpener designed to ensure a pencil point of correct length and close concentricity with the shank of the holder. The hinged tracer arm carries a spring-loaded tracer point connected by a Bowden cable to the pencil assembly.

This assembly comprises a simple weight-operated mechanism in which a slotted link ensures that the pencil point is maintained in

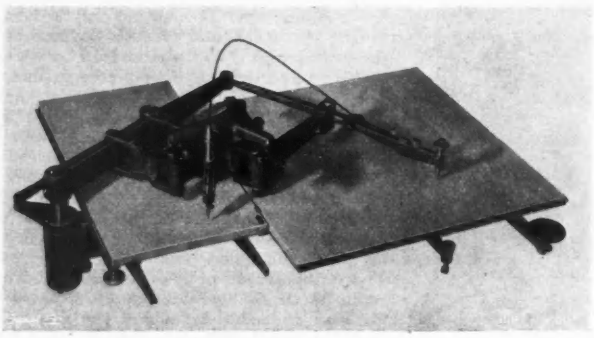


FIG. 1—ISOMETRIC PROJECTION MACHINE

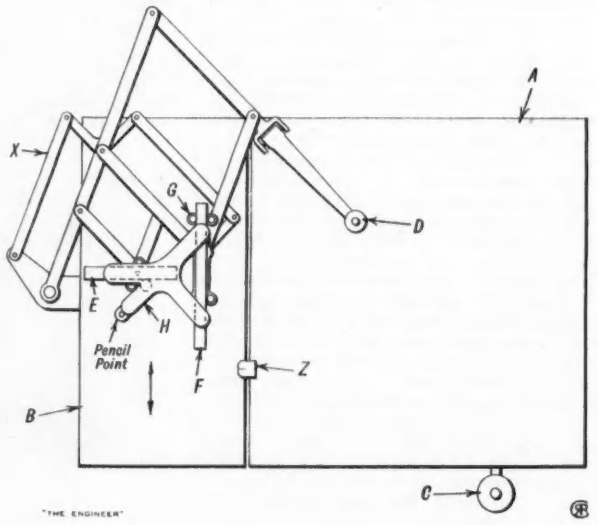


FIG. 2—DIAGRAMMATIC ARRANGEMENT

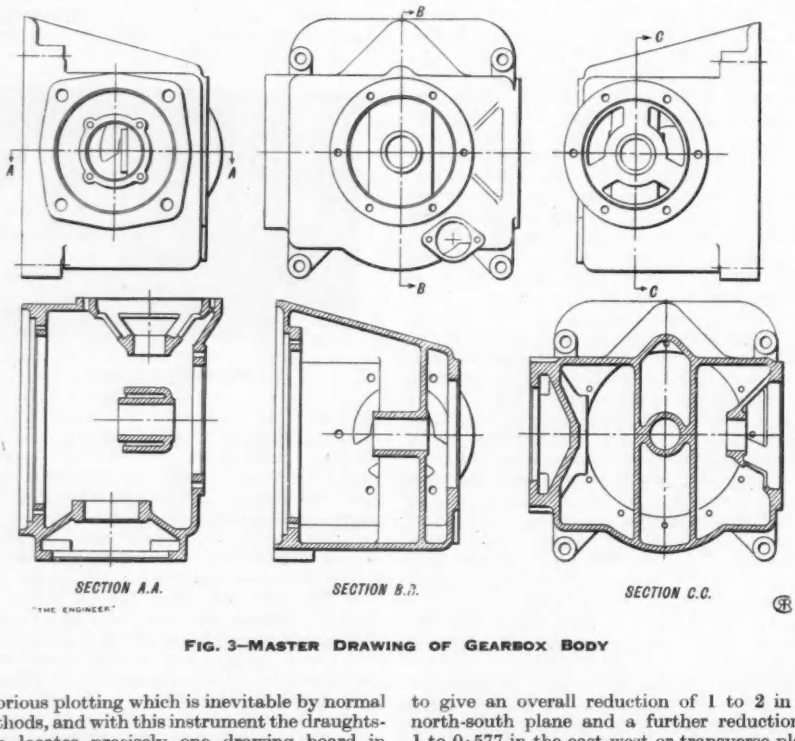


FIG. 3—MASTER DRAWING OF GEARBOX BODY

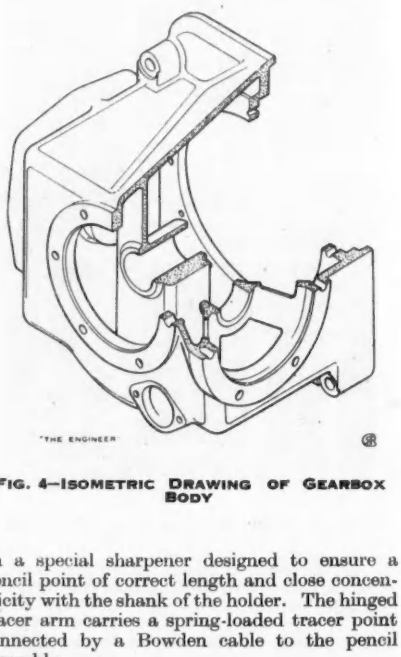


FIG. 4—ISOMETRIC DRAWING OF GEARBOX BODY

contact with the paper at an even pressure. The loading on the pencil is effected by means of a small weight and it is thus independent of the amount of pressure applied to the button by the operator. If required, extra pressure can be added to the pencil point by the addition of further small weights.

The compound pantographs are made in aluminium alloy and although extremely light are rigid and the use of ball bearings at all moving points makes for smoothness in operation. Wear on all the bearings is negligible. At no time do they ever make a complete revolution.

For the purposes of producing an isometric drawing the makers have supplied a standard reduction chart for use in conjunction with the instrument. By means of this chart a linear scale can be made which determines the amount of foreshortening necessary on each horizontal change of section on the elevation of the master drawing. This scale is attached to the movable

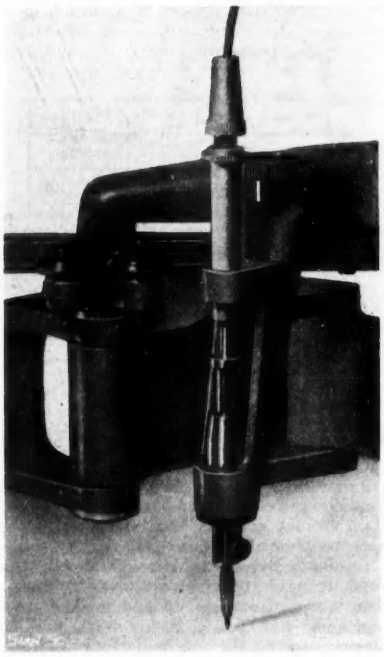


FIG. 5—PENCIL POINT ASSEMBLY

board in relation to the index pointer Z at the top of the fixed board. It is interesting to note that only the plan view on the master drawing is used when tracing for an isometric view, the controlled movements of the pantographs producing a true isometric ellipse at the pencil point on the movable board. For east-west dimensions the movable board is traversed by the handwheel C making reference to the scale in respect to the index pointer Z.

Accessories include radius arms of various lengths fitted with pin points for rapid and accurate positioning on the master drawing. On these arms, which are designed to give diameters up to 25in, the spacing of the holes for the tracer point are 0·050in apart. For all circles of less than 1·25in diameter circular grooves are provided in specially designed French curves, a number of which are included, as also are a transparent T-square and set-squares.

We are informed that the makers have introduced a service for the preparation of isometric drawings by their own draughtsmen.

THE ALUMINIUM DEVELOPMENT ASSOCIATION.—The annual report of the Aluminium Development Association, which has just been published, shows the comprehensive nature of the work carried out during 1947. Researches undertaken by the Association include structural investigations at the Universities of Cambridge, Birmingham and Bristol concerned with the properties of aluminium alloy struts, the fundamental properties of aluminium alloy beams, and basic problems associated with large riveted joints.

South African Railways

SHORTAGE OF MATERIALS

MUCH concern is being caused at present in South Africa by the prevailing shortages of many essential materials, such as axles, tyres, boiler plates, boiler tubes, spring steel, reinforcing rods, bars, plates, galvanised sheets and electric equipment. Nevertheless, the railway administration has, with the material at its disposal, been able to make reasonable progress with some of the more urgent works. An example, outlined below, is the progress already made in connection with electrification on the West Rand, a project of considerable importance in view of the growth of Vereeniging and the rapid developments in the area between Johannesburg and Klerksdorp.

Overseas suppliers have again been asked to speed up deliveries of coaching-stock. Third class traffic was so intense in December that on twenty-seven occasions it was unfortunately necessary to use covered trucks for short distance native traffic. The acquisition of third-class coaching stock is a matter of such urgency that special representations are being made to manufacturers. The supply from Europe of electric material required for urgent new works has not come up to expectations. Traction substation material needed at Salt River was due to have been delivered in February but has not yet arrived. The bulk of the equipment has, however, left Switzerland and efforts are being made to get shipping.

INCREASES IN MATERIAL COSTS

A few months ago it was mentioned that the cost of one mile of main line material had increased from £3027 in 1938/39 to £8020. It is interesting to note that in the same period the cost of a "19D" branch-line engine has advanced from £5334 to £22,500, and a bogie B-type truck from £488 to £1400. In 1939 the price of a 1200 h.p. electric unit was £11,925; now, a 2500 h.p. unit costs £55,000. Many other comparisons could be given, all indicating the same thing—that in the matter of commodity prices the railways have to face one of the most serious of present day problems.

NEW ROLLING STOCK ACQUIRED

Altogether, 110 new locomotives and electric units were placed in traffic during 1947, as compared with sixty-five in 1946. The quota was made up of fifty class "15F," twenty-one class "19D," twenty-seven class "GEA," two class "S-I" and ten electric units. Also, during 1947, 2614 new goods wagons were added to railway resources, as against 3278 in 1946. The following were also placed in service—1907 bogies, 610 shorts and 97 narrow gauge wagons, bringing the total to 66,005 goods vehicles of all types, as compared with 64,290 at the end of 1946. In December, which was a fair month, local industry produced 115 goods vehicles and 107 of different types were either erected or manufactured in railway workshops. In November, 260 new trucks were placed in service.

ELECTRIFICATION ON THE WEST RAND

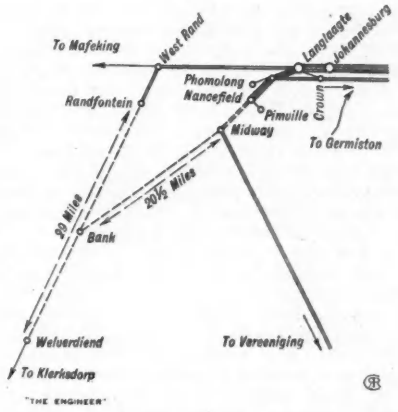
With more gold mines coming into production in the Western Transvaal and with industry on the West Rand marching ahead, railway development has had to be adjusted accordingly. The electrification of the lines between Nancefield, Midway and Bank was decided on in 1946 and good progress is being made. A construction depot was laid out at Bank on August 1, 1946, and offices, together with a Bellman hangar to serve as workshop and store, plus European quarters and a non-European compound were provided.

Construction work began in September, 1946, with the casting of the foundations for the steelwork on the Midway-Bank section, and by January, 1947, the inter-station sections were completed, and the gangs were transferred to the Randfontein-Welverdiend section.

In addition to the work already undertaken on the single-line track sections between Randfontein and Welverdiend and between Midway and Bank, a beginning has been made with the electrification of the double track sections between Midway and Nancefield. This work will materially improve the transport conditions for non-Europeans in the Nancefield-Kliptown area. The electrification of these sections entails the erection of sub-stations at Randfontein, Bank, Welverdiend, Westonaria and Midway, with the stations at Oberholzer, Goudryk, Zuurbekom, Nancefield and one between Middelvlei and Vleikop. It is estimated that the cost of electrifying these sections, which will be ready for full electric traction by the end of July, 1949, will total nearly £600,000. The diagram herewith indicates the extent of the scheme.

NEW WORKS

The new locomotive depot at Sydenham (Port Elizabeth) has now been brought into use and should be wholly completed at an early date. It has a ten-track engine shed with the accompanying facilities making up a modern locomotive depot, coaling being effected from a 1200-ton elevated stage. At Bethlehem the present locomotive depot is being remodelled



SITUATION OF NANCEFIELD, MIDWAY AND BANK

appreciably to improve its present lay-out and the earthworks necessary are nearing completion. Additional ashpits, drop pits and buildings are in hand. The new workshops at Langlaagte for the road motor transport department are now well under way.

Between Canada and Booysens, good progress has been made on the improvements and quadrupling of the Rand Mineral line. On this undertaking the earthworks are heavy and several hundred thousand cubic yards of material will require to be handled in the construction of banks and cuttings.

PROJECTED WORKS

A comprehensive scheme of railway development estimated to cost about £1,000,000 is being embarked on this year in Germiston—South Africa's largest and most important railway junction—and already much of the preliminary work is being done. Of this figure a considerable sum has been set aside for extensions to the railway station. To cope with the tremendous increase in passenger traffic, which has characterised the post-war years, three additional island platforms will be erected as part of the new scheme. When all the island platforms have been built there will be seven tracks running through Germiston, and this will enable a much larger number of trains to be handled at the same time and so considerably expedite work at the station. The work of doubling the line between Germiston and Vereeniging is already in hand. All unnecessary curves will be eliminated and the whole line will be electrified.

An assurance that the linking of the Natal and Cape Railway systems by a new line between Kokstad and Umtata would be part of the railway's next general construction programme was recently given by the Minister of Transport, Mr. S. F. Waterson. It is, however, generally considered that this general construction programme, which is expected to involve some £90,000,000 will be held back until the administration is sure that it is going to get value for the money.

Metallurgical Topics

Iron and Steel Research in Germany

THE Verein Deutscher Eisenhüttenleute has issued a comprehensive statement of its activities during the years 1946 and 1947.* The Federation was fortunate in that its headquarters escaped serious damage during the war but the task of endeavouring to restore pre-war services to its members has been a formidable one. During the period under review steady and substantial progress was made towards that end. Much of the report is taken up with details of the activities of various committees dealing with special materials or serving the special industrial interests of members of the Federation; but for others, outside, the principal feature of the report is perhaps what is said on research and publications. As is well known, it was found possible to resume publication of the Federation's journal, *Stahl und Eisen*, in its familiar form in January, 1947. Present circumstances, however, impose severe limitation on the size of the journal and, unfortunately, approval has not yet been obtained for the regular publication of *Archiv für das Eisenhüttenwesen*. In order to deal with some of the reports of the Kaiser-Wilhelm-Institut für Eisenforschung that have accumulated, it is nevertheless hoped to issue at irregular intervals special volumes, the first of which is to appear shortly.

The Kaiser-Wilhelm-Institut is closely connected with the work of the Federation and details of some of its activities are also given. Since the summer of 1946, when approval was obtained for reconditioning the buildings at Düsseldorf, good progress has been made in the re-equipment of the laboratories in spite of very great difficulties, both personal and material, and a return from the Mining Academy Clausthal, to which the Institute was evacuated in 1943–44, was possible by the end of 1947, though work is carried on under serious disadvantages, some of which will, it is hoped, be remedied in 1948.

Experimental work was interrupted at the end of the war and not resumed until March, 1947, the interval being used by the staff in writing up work carried out during the war. A list of eighty-five reports was given in *Stahl und Eisen*† and fifteen of them will be published in a special volume of *Archiv*.

An indication of some of the work which is at present being undertaken by individual members of the staff of the Institute is also given. W. Oelsen, in association with H. Maetz, is examining the behaviour of sulphur in the blast furnace and assessing the value of methods of desulphurisation which have been applied in practice. The high-frequency foundry is now in working order and W. Fischer is studying desulphurisation in the high-frequency furnace in relation to temperature, carbon content of bath and composition of slag. W. Lueg continues work on the cold-rolling of flat wire and W. Schlüter on the kinetics of transformation in chromium-manganese steels. New equipment is being devised for magnetic and thermal analysis by W. Jellinghaus, and for high speed testing by K. Fink, while H. Möller is engaged in studying changes that occur during fatigue.

Further work is planned with the object of utilising poor German iron ores and developing the use of oxygen in metallurgical processes. Such subjects as powder metallurgy and the development and use of the electron microscope for metallurgical investigations appear on the list, of which it is truly said that it is easier to think of promising lines of research than to carry them out with the restricted means and time now at the disposal of the Institute's staff. These limitations are to some extent self-imposed, since the Institute has agreed to undertake at high priority those practical tasks which have become necessary owing to the disablement or closing down of many works' research and experimental establishments. Though this will for the present retard the normal work of the Institute, viz., the furthering of fundamental research, the strengthening of the bond between science and industry will no doubt be to the ultimate advantage of both sides.

Stahl und Eisen, March 25, 1948, pages 103–113.
†*Stahl und Eisen*, March 27, 1947, page 132.

Copper-Aluminium-Silicon Alloys

COPPER alloys containing various amounts of aluminium and silicon are of considerable commercial interest. A preliminary survey of these alloys, made by L. J. Brice* in 1931, showed that with 5 per cent of aluminium the addition of silicon up to 2 per cent improved the general properties of the α solid solution, whilst further additions increased hardness and tensile strength, but reduced toughness and ductility, the 3·5 per cent silicon alloy approximating in properties to those associated with the 10 per cent aluminium-bronze. The 7·25 per cent aluminium alloy showed a good combination of properties with 1 per cent silicon; quenching this alloy had a marked toughening effect. About 1·9 per cent silicon gave the best combination of strength and ductility in the 7·25 per cent aluminium alloy, but beyond 2 per cent the extra hardness was produced at considerable expense to ductility, and with more than 3 per cent silicon the ductility and toughness of the alloys in all conditions of heat-treatment were so low as to render them useless for practical purposes.

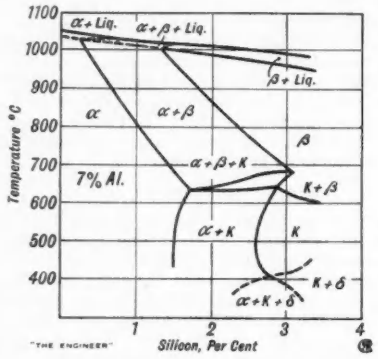


FIG. 1—*Section of Copper-Aluminium-Silicon Diagram at 7 per Cent of Aluminium (Wilson)*

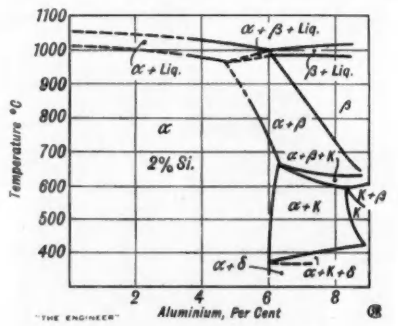


FIG. 2—*Section of Copper-Aluminium-Silicon Diagram at 2 per Cent of Silicon (Wilson)*

TABLE I.—*Mechanical Properties of 91 : 7 : 2 Copper-Aluminium-Silicon Alloy*

Copper 90·72, Silicon 2·03, Aluminium (by Difference) 7·25 per Cent

	Rods		Forgings
	Hard (*a*)	Soft (*b*)	Hot forged
Elastic limit, tons per square inch	22·8	9·4	9·4—13·4
Yield Strength, 0·1 per cent offset, tons per square inch	22·8	12·9	11·6—17·9
Yield strength, 0·5 per cent offset, tons per square inch	24·1	14·7	13·8—19·2
Tensile strength, tons per square inch	42·4	35·7	34·8—39·3
Elongation, per cent	25	38	42 — 33
Reduction of area, per cent	37	40	43 — 37
Brinell Hardness, 10mm/500kg	140	126	118 — 140

(*a*) Extruded rod, under 1in diameter, cold drawn 10·5 per cent.
(*b*) Annealed 1 hour at 760 deg. Cent.

At the present time the alloy claiming most attention is that containing about 7 per cent of aluminium and 2 per cent of silicon, which has an attractive combination of high strength and excellent machinability. Some of its mechanical properties are shown in Table I.† The constitution of this alloy has been in doubt since C. S. Smith‡ and A. G. H. Anderson,§ both in 1940, identified a new phase (kappa) in the copper-silicon system. A re-examination of the copper-rich corner of the copper-aluminium-silicon diagram has been made by F. H. Wilson,‖ who gives, with a number of isothermal sections, two vertical sections with constant aluminium and constant silicon respectively. In the binary copper-silicon alloys κ, formed at about 850 deg. Cent., does not exist as a single phase below 650 deg. Cent., but in the presence of aluminium it continues to a lower temperature. The 91 : 7 : 2 copper-aluminium-silicon alloy shows an α+κ structure in the air-cooled condition. The valuable machining properties of the 7 : 2 alloy seem to result from the presence of κ, which in the specimen under examination was drawn out into strings, probably owing to its having been made as an extruded bar. Above 650 deg. Cent. the alloy consists of α+β, but, as in the binary copper-aluminium alloys, β cannot be retained by quenching. The effect of quenching is to produce an acicular structure.

The effect of rate of cooling on the transformations in which κ is involved, and the influence of κ on the mechanical properties of the alloy will require further investigation, but the present work of F. H. Wilson goes far towards providing a fundamental basis for understanding these alloys, and will assist in the selection of well-balanced compositions which may prove to be of no less interest than the 91 : 7 : 2 alloy.

* L. J. Brice, *Jour.*, Inst. Metals, 1931, Vol. 45, page 209.

† R. A. Wilkins and E. S. Bunn, "Copper and Copper-Base Alloys," McGraw-Hill Book Company, 1943, pages 263–265.
‡ C. S. Smith, "Trans.," Amer. Inst. Min. Met. Eng., 1940, Vol. 137, page 313.
§ A. G. H. Anderson, *ibid.*, page 334.
‖ F. H. Wilson, Amer. Inst. Min. Met. Eng., Tech. Pubn. No. 2329, *Metals Technology*, February, 1948.

Jominy Tests on Aluminium Alloys

THE principle of the Jominy test for the investigation of the hardenability of steel is now very familiar. A standard cylindrical specimen, uniformly heated to a predetermined temperature, is quenched on one end-surface by a jet of water, and hardness values at various distances from the quenched end are measured. The rates of cooling at these positions correspond to the rates of cooling of the centres of bars of various diameters, and the mass effect of these sizes may be deduced from the hardness values at the appropriate positions on the Jominy test piece of the steel in question. The Jominy test has afforded a vast amount of information about the influence of alloy elements on the hardening characteristics of steels, and its use has now been extended to the study of commercial age-hardening aluminium alloys. The hardening properties of these alloys depend on the retention, wholly or in

part, of a supersaturated, solid solution, and on its subsequent breakdown. To obtain the best properties it is necessary for the cooling rate to be sufficiently high to maintain the required degree of supersaturation in the solid solution.

Little quantitative information is available about the effect of various initial cooling rates on the mechanical properties of age-hardening

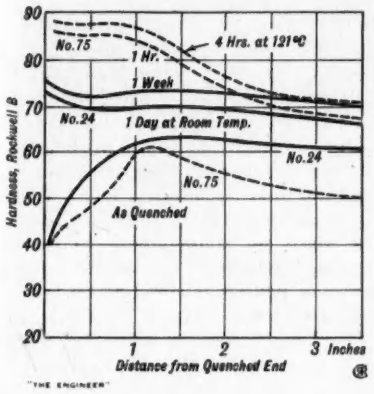


FIG. 1—*Jominy Tests on Alloys 24 and 75 (Loring, Baer and Carlton)*

aluminium alloys. To amplify this, B. M. Loring, W. H. Baer and G. M. Carlton* have, by means of the Jominy tests, investigated five aluminium alloys in the form of 1½in to 1¼in diameter extruded rod. A modified form of Jominy specimen was employed. The composition of the alloys was as follows :—

Type	Cu	Si	Mn	Mg	Zn	Cr	Fe
14 S ...	4·51	0·82	0·73	0·25	—	—	0·33
24 S ...	4·22	0·12	0·62	1·46	—	—	0·27
61 S ...	0·17	0·51	—	0·92	—	0·26	0·22
75 S ...	1·44	0·61	0·23	2·51	5·68	—	0·11
R 301 ...	4·68	0·92	0·79	0·44	—	—	0·35

Typical curves, redrawn from those given in the paper, are shown in Fig. 1. There is an apparently critical rate of quenching which may be recognised in all the alloys used in this investigation. Higher rates of cooling cause a progressive decrease in the hardness of the quenched alloy whilst lower rates produce relatively little change in hardness, and the widely different rates of cooling have little effect on the hardness of the alloy after ageing. In these respects No. 24 was typical of all the alloys examined except No. 75. Alloy No. 75 showed

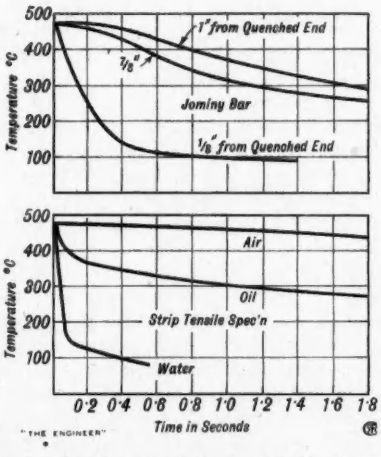


FIG. 2—*Time-Temperature Curves of Cooling Rates of Alloy 24 (Loring, Baer and Carlton)*

a fall in hardness when cooled at rates characteristic of positions more than 1½in from the quenched end of the Jominy test piece, and in this alloy, also, the low hardness due to rapid quenching gave rise to higher hardness after ageing.

In Fig. 2 the rates of cooling at different positions on the Jominy test piece are compared with rates of cooling of a specimen (approximately 1in by 8in and 0·1in thick) in different quenching media. The diagram is itself a warning against assuming equivalence between cooling rates at different Jominy positions and in different media. For example, the temperature falls to 300 deg. Cent. in about 1·2 seconds at ⅛in from the quenched end of the Jominy test piece and also in a strip cooled in oil, but the time-temperature relations during the first second are entirely different. In a study of the effect of quenching in different media the Jominy is unlikely to be of much value ; but, on the other hand, the use of the Jominy test may prove to be important in the investigation of age-hardening alloys which are to be used for massive sections.

Low-Temperature Treatment of Steel

An article on the sub-zero treatment of tool steel, appearing in these columns a few months ago,* recorded the conclusion that the development of the technique of sub-zero treatment of steels for which it proved to be specially adapted would be more effective than its general application to the standard tool steels.

This view receives support from work on the low-temperature treatment of steel, carried out by H. E. Boyer and described in the *Iron Age*.† Although the paper deals in part with tool steels, it does not contain any results of machining tests. The treatment was based on the indications of the appropriate isothermal transformation diagrams, and its efficacy was deduced from measurements of residual austenite and of hardness. The results obtained on five types of high-carbon steels are summarised in Table I. They were heated to the most suitable temperature for hardening, and also to a temperature 300 deg. Fah. higher, except steel C (18–4–1 tool steel), which would have undergone incipient melting at that temperature. In every case the amount of austenite was diminished and the hardness increased by the low-temperature treatment. The change was most marked when the steels had been austenitised at an abnormally high temperature, but this fact is not of much practical value as optimum conditions of treatment would normally be used in the first place. Only in this limited way can the process afford any aid to the correction of maltreatment. It has no influence on undissolved carbide or other effects of too low an austenitising temperature.

It is very rarely that any of these steels would be put into service without undergoing some tempering treatment. At a certain tempering temperature the austenite begins to transform, and at a still higher temperature the transformation is complete. When a tempering temperature is reached at which no austenite remains, a subsequent sub-zero treatment has no effect. At this temperature considerable softening of the martensite will already have taken place. Such a temperature is usually higher than is desirable for the secondary hardening of steels C, D and E. For example, steel C was heated to 1050 deg. Fah. (565 deg. Cent.) for secondary hardening, after which it still retained 18 per cent of austenite, which was reduced to 10 per cent when the tempering was preceded by sub-zero treatment. It is, however, generally agreed that a multiple tempering cycle is desirable for this steel, and some further transformation would have been effected by the additional tempering.

Boyer concluded that sub-zero treatment should be applied as part of the hardening process before tempering, otherwise it was much less effective. If, however, it was intended to temper at not more than 400 deg. Fah. (200 deg. Cent.) the effect on subsequent sub-zero treatment would be slight, and the sequence of operations did not matter very much. Usually, sub-zero treatment should be applied as soon as possible after the quenching, as austenite tends to become more stable after long periods. If the specimen is cooled in still air, as in a refrigerator, the time of exposure should be about one hour per inch diameter or thickness ; if in a liquid the time may be very much shorter, and if the surface only requires hardening the time may be correspondingly reduced. Repeated cooling to —125 deg. Fah. had little additional effect. Sudden cooling may cause cracking, and if a liquid is used it is desirable that the cooling be done in two or three steps.

The most useful application of sub-zero treatment in Boyer's opinion is to high-alloy case-hardening steels, such as those containing 5 per cent of nickel, or nickel 3·5, chromium 1·5 per cent. Results on these are given in Table II. Another type which is said to benefit is the high-carbon, high-chromium steel for dies, which cannot usually be tempered at a sufficiently high temperature to eliminate the residual austenite. In gears it is desirable to have not only high hardness, but freedom from austenite at the surface. Such steels readily respond to a sub-zero treatment with consequently improved properties.

TABLE I.—*Summarised Data on High-Carbon Steels, from Diagrams Given by Boyer*

	A	B	C	D	E
Composition, per cent :					
Carbon	1·04	1·00	0·72	2·05	1·07
Manganese	0·28	0·30	0·32	0·30	0·36
Chromium*	—	1·42	4·10	11·75	17·20
Molybdenum	—	—	—	0·80	0·48
Tungsten	—	—	17·80	—	—
Vanadium	—	—	1·05	0·20	—
Treatment	Water quenched	Oil quenched	Air cooled	Oil quenched	Air cooled
Austenitising temperature,† deg. Fah.	1450 1750	1550 1850	2325 2425	1800 2100	1950 2250
Retained austenite, percentage by volume :					
After cooling to 75 deg. Fah.	9 13	12 17½	27½ 30	35 96	45 97½
After treatment at —125 deg. Fah.	6½ 9	8 9	18 20½	24 71	36 95
Hardness, Rockwell C :					
After cooling to 75 deg. Fah.	66	65	64	65	60
After treatment at —125 deg. Fah.	67	67	66	68	62
Tempering temperature, deg. Fah., for 100 per cent transformation of austenite	425	475	1350	1300	1025

* In the original table erroneously given as " Co."
† In each case the first mentioned is the optimum.

TABLE II.—*Effect of Sub-Zero Treatment on the Hardness of Case-Hardened Alloy Steels*

	1	2	3
Composition, per cent :			
Carbon	0·18	0·13	0·15
Nickel	1·76	5·0	3·60
Molybdenum	0·25	—	—
Chromium	—	—	1·60
Surface hardness,* Rockwell C :			
As quenched	57	51	46
After sub-zero treatment	62	60	62

* Tested with a superficial Rockwell tester, using " 15 N " scale and converted into Rockwell C numbers.

Approximate equivalents :					
Rockwell C	46	52	58	60	62
Vickers diamond	486	563	652	692	740

* B. M. Loring, W. H. Baer and G. M. Carlton, " The Use of the Jominy Test in Studying Commercial Age-Hardening Aluminium Alloys," American Institute of Mining and Metallurgical Engineers, Technical Publication No. 2337 *Metals Technology*, February, 1948.

* THE ENGINEER, September 26, 1947, pages 292–3

† *Iron Age*, Vol. 161, 1948, February 12th, page 69 ; February 19th, page 78 ; February 26th, page 90

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NATIONALISATION AT SCARBOROUGH

IT has been suggested in the daily Press that it was the menacing loom, in the not distant future, of a general election in which the Labour Party is unlikely to win the easy victory it attained in 1945, that made certain of that Party's leaders at Scarborough seem more chary than of old in recommending that further industries should be nationalised. It is, indeed, far from impossible that when Mr. Morrison, advocating a slower tempo, said "the party should remember that Ministers must have adequate time to consolidate and make efficient or more efficient the industries already socialised," he was seeking to propitiate the middle and professional classes whose votes will have so much influence on the coming election. But we doubt whether that was all that he had in mind. For other words of his and from Mr. Attlee sounded a note of reality too disillusioning to ideological hopes to be wholly electioneering. "The greatest task ahead of us," said Mr. Attlee, "is to see that the citizens' sense of obligation to the community keeps pace with the changes we are effecting in the structure of society. We need to stress duties as well as rights. . . ." Nationalisation, in fact, is not an end in itself. It affects nothing unless there is a change of heart within the industry, a change of heart affecting not managements alone but the workers as well.

It was always obvious to those who opposed nationalisation of industries that the mere change of ownership could do little or nothing to advance the hopes of workers for better conditions, higher wages, shorter hours of work and representation on the management. For a change of ownership cannot alter the economic surroundings in which an industry must work. Nor need it necessarily have any effect (except, perhaps, for the worse through undue centralisation of management) upon industrial relations or upon output, efficiency, or anything else. Something does, indeed, depend upon the personalities of those who are given charge of such great monopolies. But it is far less than many socialists would like to believe. For a great part of the energies of those in charge must for years be given up to the development of a new nation-wide organisation in replacement of the local organisation that went before. Moreover, an industry is not a concrete thing that can easily be chipped and hacked into a new form. It is a great collection of individuals of differing capacities and talents, differing skills and intelligences, working together in the pursuit of a common purpose. The atmosphere, whether it be one of hostility or friendliness between managements and men, whether it be one of energy and resourcefulness or staleness and slackness, depends upon the views and actions of all these people and their reactions to their economic surroundings. Nor if the industry, while it was in private hands, was deemed inefficient by its critics can mere nationalisation bring about a change. For, apart from a few members of the new ruling Board, the very same men that directed it before the change must, as being the only people with sufficient knowledge of its workings, be those that direct it after; and the very same workpeople must be employed by the nationalised industry as worked for the industry before the change was made. Only if all, managements, executives, and men are substantially agreed upon the improvements that it is desirable to bring about, and even then only if the economic situation is favourable, can improvements be secured. And if those people are already agreed (as, for instance, they are in the iron and steel industry) modernisation of plant, development of techniques and modification of industrial relations will come about whether or not the industry is nationalised. Nationalisation, indeed far from helping, is likely to hinder the work by calling for a reorganisation of management with all the unsettlement that such work implies.

But the workpeople of this country built high hopes upon nationalisation. Nationalisation of this industry and of that was to become the sign that a new order had been evolved. Disillusionment was bound to follow when nationalisation was tried. For one cannot create a socialist state by Act of Parliament. But it is remarkable that disillusionment should have come so soon. Already it is evident amongst the coalminers. Soon we believe it to be inevitable that it will spread amongst workers in other nationalised industries. The wiser heads in the Government have long since been driven by the cares of office and by consideration of the serious economic position of the country to a realisation of the point that it is not the carrying out of ideological social democratic plans, not the mere redistribution of wealth, that will raise the standard of living and improve the security of the worker. It is sheer hard work upon his part accompanied by increased output. We need to see again enthroned the almost forgotten Victorian virtues of thrift and application to the job. Again and again at Scarborough Mr. Morrison stressed the point. "The test now must be that the social security state cannot endure unless it is also a state of social responsibility"; and, again, "Socialists have sometimes been so preoccupied with the problems of fair distribution that they have not tackled in detail the problem of securing full production"; and once more, "If every one next year can put as much effort into pressing prices and costs down as has been put into forcing wages up and securing reduced working hours we shall all be the gainers." These are hard words for trade unions to stomach. They ask, indeed, for an almost complete reversal of policies followed by trade unions for fifty years and more. But the workers and their trade union leaders still seem to lack conviction that the only road to higher living standards and greater security lies through greater and greater output.

THE U.N. ATOMIC ENERGY COMMISSION

THE Atomic Energy Commission of the United Nations has tried hard to discover a plan for the control of atomic energy which would be acceptable to all nations. In a certain sense it almost succeeded, for in the critical vote 80 per cent were in favour of a specific plan then lying on the table. In any ordinary Committee this would be thought reasonably satisfactory, but in this instance it could not; for one of the dissenting voters had the power of veto on the Security Council to which the Commission's findings must needs go for confirmation. The basic difficulty throughout the long discussions was that this mainly technical matter was treated as a political issue. From the technical point of view it was requisite that the whole world should be treated as a single unit, in which all matters relating to atomic energy could be controlled by one single authority. Unless this were done no nation could safely bind itself to accept the hazard of atomic disarmament since any such commitment must weaken the position of really honest states in relation to that of the less honest ones, who would promise much but perform little and this without the check of some independent scrutiny to ascertain what was really happening, and without power to set right anything found to be wrong.

It would have been no small gain in a disordered world that with the creation of a world authority for the control of atomic energy a limited but important advance would have been made towards the transfer of a certain measure of power from national governments to an organ of supranational control, and there were many who considered that this might well be the best means for solving common problems not only of atomic energy but of disarmament in general and the highly complex questions of food supply, population density and the like. In this way the greater happiness of the various divisions of the human race, in their varying modes of life, might have been materially aided. But in much of the political world such things are looked on differently. Marxian theorists, for example, seem not to want the rest of the world to be happy unless travelling by their

own particular route to that end; they believe that the western world is economically so unsoundly based that its collapse and dissolution is but just "around the corner," so why not, they ask, await that happy event and do everything possible in the meantime to make the non-Marxian states as cheerless and distraught as they can be? In such a political atmosphere as this the Atomic Energy Commission could not be expected to succeed and we note, without surprise, that one of its Committees has lately, though regretfully, concluded that the present task of the Commission had better be suspended; advice which has been accepted by the Commission and will now go before the General Assembly in formal session. What the result will be has yet to be revealed, but it would hardly be surprising if the Assembly should feel bound to agree, however reluctantly, with the view thus expressed.

If U.N.O. has to give up, for the moment, the task of finding a universally acceptable scheme for controlling atomic energy—for the good reason that none has yet proved discoverable—where do we go next? The answer, so much feared, can only be that the atomic race is now on, and is indeed intensified. This fear and the possible danger to the world may nevertheless be easily exaggerated. It fortunately happens that at the present time a non-aggressive power, the U.S.A., is easily first in the race and can with little difficulty so remain, both in respect of quality and quantity, if it earnestly desires to do so—as at present it unquestionably does. It is true that from an engineering point of view one unfortunate consequence must be that with the division of the world into competing fractions, there will be hindrance and delay in the prospective use of atomic energy for civil power production on land or sea—and some day, perhaps in the air. On the other hand such civil developments must, in any case, be slow in coming to fruition, since the practical problems to be overcome are so many and so exceedingly complex. One of considerable magnitude but not often discussed is the disposal of the waste products of the power-piles. These fission fragments, as they are called, may be any out of a dozen or more elements of various degrees of radio-activity and very different lengths of life. Some may be useful in medicine and for research. But others will not, and being potentially dangerous to life will somehow have to be got rid of. From information given in the *Chicago Bulletin of the Atomic Scientists*, for April, 1948, always an informative journal, it seems that for each 10,000,000kWh of heat produced by a power plant 1 lb weight of these fission products will be produced. For whatever period of time those derived from any particular plant continue to be violently radio-active they will have to be disposed of somewhere until their active life has come to a close. Little is published on such matters, but we know that there exist among the less stable elements some with "half-lives" of but a fraction of a second and some with spans measured in years. Unless sufficient uses can be found for all such products, this problem may well rival in its complexity the better advertised ones, relating to the best materials to use in the construction of power-piles, in the casing of the uranium rods, and suchlike matters. Fortunately, there is nothing to hinder these technical matters continuing to be investigated by the western countries of the world, so that by the time—whenever it comes—that the political world is ready for something not too unlike the well thought out Lilienthal-Baruch plan of control, the technical knowledge to give full effect to its potential benefits may then be fully available.

Obituary

PROFESSOR W. T. DAVID

MANY of our readers will learn with deep regret of the death on Saturday, May 22nd, suddenly, in the Leeds General Infirmary, of Professor W. T. David at the comparatively early age of sixty-two. For many years he has been Professor of Civil and Mechanical Engineering in the University of Leeds.

William Thomas David was the son of the late Mr. S. David, of Laugharne, Carmarthenshire, and was born in 1886. He was educated at St. David's School, and in 1902 he went up to the University College, Cardiff, to continue his technical training. In 1906 he gained the B.Sc. Electrical Engineering Degree (Wales). After two years of practical training in the Salford Iron Works of Mather and Platt, Ltd., he went up to Cambridge to Trinity College, taking the M.A. and D.Sc. degrees, and later the D.Sc. (Wales). He spent some years on internal combustion engine research under the late Professor Bertram Hopkins, of Cambridge.

After leaving Cambridge he joined the firm of Mather and Platt, Ltd., of Manchester, as assistant in the gas engine design department under the late Mr. Alan E. L. Chorlton, with whom he worked until 1912. His next position was with the Board of Education as Inspector of Technical Schools, which he held until after the outbreak of war in 1914. In 1915 he was appointed Inspector of Gun Ammunition Filling Factories. He joined the Army with the rank of Major and was appointed to the Inspection and Research Staff. From 1915 until 1917 he was Director of Dilution of Munitions Labour at the Ministry of Munitions, and later had charge of the Dilution of Shipyard Labour at the Admiralty. He also assisted the late Sir Robert Horne in the Demobilisation Section of the War Cabinet.

In 1918 for a year he again served the Ministry of Education as an Inspector of Technical Schools (Engineering). In 1920 he was made Professor of Engineering at Cardiff University, and two years later he accepted the appointment as Professor of Civil and Mechanical Engineering in the University of Leeds. Later he became Dean of the Faculty of Technology. He was a member of the Institution of Civil Engineers, and the Institution of Mechanical Engineers, and gave several papers which were published in the "Proceedings" of those Institutions. His work of the Cambridge period on the researches connected with gaseous explosions was published in the "Transactions" and "Proceedings" of the Royal Society. He contributed some interesting articles to THE ENGINEER and other technical journals on engine testing and various aspects of the combustion process.

"CHOOSING VALVES."—The third edition of an illustrated book entitled "Choosing Valves" has been issued recently by Glenfield and Kennedy, Ltd., Kilmarnock. It contains a series of articles dealing with the choice of valves, which was written by Dr. P. L. Boucher for the guidance of engineers concerned with waterworks and pumping practice. It includes also some useful appendices in the form of tables relating to the flow of water in asphalted cast iron pipes, B.S. pipe flanges, and B.S. cast iron pipes for gas, water and sewage.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

THE BRITISH MACHINE TOOL FUTURE

SIR,—Referring to Mr. Catmur's letter on The British Machine Tool Future. The machine tool firms know the limits of size and type for which their shops are suitable, they know the specialised qualifications of their designing and shop staffs, and they know (or should know) the lines along which their customers are moving. Would it not be better to drop "guiding," "encouraging," and "directing" by officials who do not know these things and leave the skilled engineers to do their job?

F. L. WATSON, M.I.C.E., M.I.Mech.E.

Lyndhurst, Hants, May 23rd.

MANAGEMENT

SIR,—The leading article in your issue of April 30th asserts that management is an art not a science. With due respect to many of your considerations, to which I readily agree, this categorical statement seems to take too narrow a view.

If management in the past and present is to blame for many shortcomings, which I think it is, this is chiefly on account of its having neglected the scientific aspects (in the first instance that which may be generally termed the available knowledge) and of having treated its subject as one on which anyone in authority is qualified by that authority. The result cannot be anything but (usually well-intended) guesswork, which by way of exception proves to be well-aimed but as a rule goes wide of the mark.

Yet, in matters of such wide practical importance it is indispensable that the aim of the majority, if not of all those employed in management, should be well directed and a good average score realised. We therefore may not rely on the few who by intuition can attain what teaching might show to many. Accordingly the science of management, a compilation—as in all other sciences—of inventive theory, experiment and corrective long-run experience, must needs be developed. Fortunately a good start has already been made, with rapidly gathering momentum, during the last half century.

Now all exceptional attainments, on which to a large measure we must rely for progress, require a combination of the craftsman's science, the artist's vision and the versatility of both. This applies to any trade or profession, whether it be the cabinet or toolmaker's, or the physician's, lawyer's, engineer's, painter's, architect's or manager's. Yet science can be taught to thousands less gifted, who in the totality of their efforts can produce results of a magnitude unattainable by the few who have the genius' unerring sense of direction, and our community cannot nowadays do without the former any more than without the latter.

It is for the few to be honoured by the many as their teachers and pioneers into the land ahead. We cannot all belong to that select company. In many professions there is, on various levels, a place for almost the full range, from pure craftsman to pure artist. In management, where not only material, but men also are handled, those who have no gifts that way cannot or should not be employed. But it is doubtful whether this is indeed primarily a matter of art or science, or rather of certain traits of intelligence and character and of training. Surely the success of a thing like T.W.I. is not due to the mastering of an art. Suitable men have had their eyes opened and were shown the way, that's all.

It would seem wise not to disparage the importance of a science of management, as, for the large majority of executives in all

grades, it will remain the fountain from which aptitude and even inspiration draws its substance. We can then, with an easy conscience, leave the "artists" to perform their own share in their own inimitable manner.

In the same article you very appropriately speak of "the art and science of engineering." It is no less correct to speak of "the art and science of management."

IR. H. C. KING

Amsterdam, Holland, May 19th.

THE CROWSNEST LINE, C.P.R.

SIR,—It is evident from Mr. Poultney's letter in your April 23rd number that I did not word my remarks on stroke-length and expansion very clearly, for which I apologise. Quoting Mr. Poultney, "it would seem to infer that a long-stroke cylinder has some advantages compared with one having a short stroke, *both presumably of the same volume*" (my italics). No, no! That's not what I meant. I was thinking of cylinders of the same *bore*. "Other things being equal," a cylinder of, say, 18in by 32in will naturally develop more power than one 18in by 24in, and in it expansion could be taken farther than in the cylinder with 8in shorter stroke. I was not thinking of "cylinders of equal volume having (1) a small diameter and long stroke, or (2) a large diameter and short stroke"—again quoting.

With regard to the degree of expansion, here again, Mr. Poultney and I were not looking at the matter from the same angle. "The only thing that effects the degree of expansion is the point of cut-off." Very true, but I was thinking of a point of cut-off in short and long-stroke cylinders measured in both cases *from the beginning of the stroke*. If a 24in and a 32in cylinder both cut off at the same distance from the beginning of their strokes the latter would have the advantage of greater expansion. Wouldn't it?

"Leverage" is covered by the first paragraph; it comes back to me that when writing about this I was laughing at a memory of boyhood that has always remained with me, and this preoccupation was probably responsible for the fogginess of the wording. This was it: a school chum and myself were keen cyclists when cycles were discussed and criticised just as cars were in the early days, and on the subject of bikes there was constant argument about it and about, despite that oftentimes we came out by the same door as in we went—kicked out by irritable elders as like as not. My chum's father bought him a fine bike, miles better than mine, but overlooked the importance of the length of his offspring's legs, with the result that the humiliated kid's feet left the pedals at the bottom of every stroke, this giving the enemy occasion to blaspheme. After some cogitation, his father decided that while only Nature could alter the length of the legs, and would probably take her time about it, a mechanic could bring quicker results by way of the cranks, and a pair was made with a throw of only 4½in. I criticised this brainwave with youthful vigour and complete lack of respect for my elders—*my* suggestion was another bike with a lower frame, and leave the blooming cranks alone. It was no good—the original idea was adopted, and the 4½in cranks fitted, with the natural outcome that the kid had to walk up every rise, the gentlest head-zephyr blew him to a standstill and I was waiting for him at every milepost. "Quite funny, but what's the point?" (possibly misquoting Mr. Poultney). Well, I can't help thinking that even as my friend would have been happier with 7in cranks on his bike, so would a locomotive working over the Crowsnest Line prefer a 32in stroke to a 24in!

Or am I as big an ass as my chum's father?

EDWARD H. LIVESAY.

Victoria, British Columbia, May 14, 1948.

The Iron and Steel Institute

No. III—(*Continued from page 496, May 21st*)

THE final session of the meeting was held on Thursday morning, May 6th, when there were again joint discussions on two sets of papers. The first papers considered were the following:—

A MICRO-EXAMINATION OF EIGHT STEELS FOR THE INCLUSIONS SUB-COMMITTEE

By J. H. WHITELEY, D.Sc., F.R.I.C.

SYNOPSIS

An investigation for the Inclusions Sub-Committee, of the number, distribution, and nature of the inclusions in a series of eight low-alloy steels is described. In determining the number of inclusions counts were made on both lengthwise and crosswise surfaces, it having been previously ascertained from the former, that inclusions not well embedded are liable to be removed in polishing. The way this conclusion was arrived at is shown. Full details of the counting procedure are presented. The results indicate a direct relationship between the number of inclusions in the steels and their combined sulphur and oxygen contents. A description of the types of inclusions observed in each of the steels is then given, their grain-sizes and macrostructures being also illustrated. In an appendix by G. Murfitt, an X-ray examination of acid-extracted inclusions in these steels is recorded.

THE STUDY OF SEGREGATIONS AND INCLUSIONS IN STEEL BY MICRO-RADIOGRAPHY

By W. BETTERIDGE, B.Sc., Ph.D., F.Inst.P., and R. S. SHARPE, B.Sc., L.I.M.

SYNOPSIS

The technique of micro-radiography is described in detail, including a simple mechanical method for the preparation of the necessary thin samples. Tables of linear absorption coefficients for different characteristic radiations are included to facilitate the identification of different segregates and inclusions. Examples of the application of micro-radiography to the study of steels are described. It is shown that the overheating of steels does not produce segregation of the metallic alloying elements towards or away from the grain boundaries of the austenitic structure. Sharply defined segregates rich in manganese are shown to be a very common feature in many steels, and it is suggested that this phenomenon is worthy of a detailed examination.

SOME THERMODYNAMICAL ASPECTS OF THE FORMATION OF INCLUSIONS IN MILD-STEEL WELD METAL

By E. C. ROLLASON, Ph.D., M.Sc., and E. BISHOP, B.Sc. (Tech.).

SYNOPSIS

A method of thermodynamical analysis has been developed and applied to published analyses of non-metallic inclusions in mild-steel arc-weld deposits. In spite of the short times involved in arc welding, equilibrium of the molten metal is largely attained at an estimated temperature of about 1710 deg. Cent., and the process of inclusion formation in weld metal has been shown to obey the general principles of thermodynamics. Inclusions analysed at room temperature and also calculated to exist at the freezing point are plotted on a ternary (SiO_2-FeO-MnO) diagram from which can be deduced the change in inclusion composition during cooling from the freezing point. Evidence is given to indicate that the oxygen content of the weld metal is determined by the FeO content of the slag, as in large-scale steelmaking. Consequently a method has been evolved whereby the types and amounts of inclusions to be found in many weld metals can be determined by using the FeO content of the slag and the total manganese and silicon contents of the weld metal. Slags containing large quantities of CaF_2, are excepted.

DISCUSSION

Mr. H. H. Burton (English Steel Corporation) said that the paper by Dr. Whiteley contained an immense amount of careful work and it was unfortunate, in view of the beautiful pictures of the inclusions in the paper, that there were not yet side by side the results of fatigue tests on the same group of steels. The method of polishing the specimens adopted by Betteridge and Sharpe seemed to be very effective and well worth noting. It was very gratifying to find that the evidence put forward by the authors of the third paper was so strongly in favour of the idea that in the formation of weld metal equilibrium conditions were reached. One thing arising out of this paper did not seem to be clear, and that was the technique adopted in obtaining the samples of weld metal. Were they just obtained by fusing two rods of weld metal together, or were they obtained on an actual weld run? If the latter, it was going to be very difficult to see which part of the weld run it represented and surely the parent metal must come into it quite a lot.

Dr. F. W. Jones (Brown-Firth Research Laboratories), commenting on the method used by Betteridge and Sharpe, said it was quite useful for giving quantitative information about the variety and different compositions of different phases present in complex steels. There was one limitation, however, and that was the need for a finer grain X-ray film, which would enable a better distinction to be made between different phases in a fine grain steel. It seemed, however, that to obtain resolution with a fine grain steel it would be necessary to decrease the thickness of the steel specimen to the same order as the grain size. Therefore, there seemed to be a limitation to the method in that the smallest grain size steel in which they were likely to be able to distinguish between compositions of the different phases was about 1000th inch, which with present methods was the thinnest sample that could be made.

Mr. K. J. B. Wolfe (B.S.A. Tools) said that in the B.S.A. Group Machinability Research Laboratories the micro-radiography technique had been used in a further effort to elucidate some of the problems associated with the effect of heat treatment on the true machinability of steel, especially under conditions of intermittent cutting. The true machinability of a steel might be described as "that complex property that controls the facility with which it can be cut to the size, shape and surface finish required commercially." Recent work on this subject had shown that the true machinability of hardened and tempered constructional steels, especially under conditions of intermittent cutting, such as shaping, planing and milling, was greatly influenced by the tempering process. It had been found that if a second temper was employed at a temperature approximately 25 deg. Cent. below that of the first, and this was followed by an oil quench, then the true machinability index of the steel would be greatly improved although the usual mechanical properties were substantially unaffected. Small variations had been noted in the microstructure, magnetic properties, Meyer analysis values, and in other properties following this treatment but not, apparently, of sufficient magnitude to explain completely the difference in the true machinability values which had been experienced. In the case of gear generation by the shaping method, improvements of up to 1000 per cent had been encountered by these means when cutting hardened and tempered nickel-chromium steel (En. 23) in the 65-ton condition (B.H.N. 270 to 280). The longitudinal microstructure of this steel showed no apparent signs of abnormal segregation on non-metallic inclusions. The examination of this steel by micro-radiography, however, indicated that manganese showed signs of severe segregation. A preliminary examination also indicated that these manganese-rich areas apparently tended to disperse during the second tempering treatment and micro-radiographic examination confirmed this. It seemed, therefore, reasonable to assume that the effect of the double tempering treatment on these manganese-rich inclusions was to cause them to diffuse and so to become less hard and consequently less abrasive. This would cause less wear on the cutting tool, but would still permit

these areas to act in a similar manner to non-metallic inclusions in a free-cutting steel. It was hoped to publish further information on this aspect of the subject in the near future.

Mr. H. A. Sloman (National Physical Laboratory) said the paper by Rollason and Bishop was a courageous attempt to predict the amounts and identities of inclusions in weld metal by the use of thermodynamic data. However, the authors had not convinced him that they had succeeded in what they set out to do. The conclusion he himself had come to was either that our present thermodynamic data were so inadequate that they could not be applied or, alternatively, he must disagree with the authors' statement that weld metal was in equilibrium for the authors could not give a picture of this equilibrium. It seemed to him that the authors had not made the best of the suggested method. Owing to the need for simplifying the very complex mathematics involved, they had only considered the equilibria with five elements, viz., iron, manganese, silicon, oxygen and sulphur. He agreed there were elements in weld metal which could be ignored but he thought the authors had unjustifiably omitted to consider the effect of hydrogen and carbon. The gaseous envelope in which the weld metal was deposited contained very large amounts of both hydrogen and carbon, in the form of CO_2 and water vapour, and there was strong evidence that the composition of this envelope affected the constitution of the deposited metal. From his limited experience he believed that hydrogen was more important than carbon in this respect.

The only published data in this country giving the result of an experimental study of the constitution of weld metal with particular reference to inclusions in the weld metal was in a paper by Rooney, Schofield and himself, before the Institute some years ago. They used various methods of obtaining a clear and accurate picture of the constitution of a series of mild steel weld metals and showed how the constitution depended either on the composition of the electrode core wire or the composition of the electrode, and all the experimental results quoted in that paper were taken from N.P.L. work. The authors now suggested that all this experimental work was unnecessary and that it was possible to use certain thermodynamic calculations to produce a picture of the inclusions in weld metal with sufficient accuracy to be quite reliable. On that, he could not agree at all. It seemed to him that the discrepancy between the calculated results and the experimental results was so large that no reliance could be placed on the calculated results unless the experimental ones were at hand to compare with.

Dr. L. Mullins (Kodak Research Laboratories) said it was important to emphasise that the technique outlined in the paper by Betteridge and Sharpe was complementary to photo-metallography, so that the method could be used in proper perspective. The photo-micrograph revealed the surface structure, and the micro-radiograph provided a shadow picture of thin slices of material. It was a two-dimensional record of a three-dimensional structure. Therefore, the specimen thickness must be comparable in thickness with the size of the particles being sought.

The authors indicated that they would reply in writing.

The final discussion was on the following papers :—

A COMPARISON OF MOULDS OF STANDARD COMPOSITION AND OF APPROXIMATELY INGOT MOULD SUB-COMMITTEE COMPOSITION

By W. L. Kerlie, B.Sc.

Synopsis

A number of ingot moulds representing two different compositions have been examined under carefully controlled conditions. Direct correlations between silicon content and mould life and phosphorus content and mould life were found, when all the moulds other than the abnormal ones were considered. The most important conclusion obtained was that with a mould composition close to the one recommended by the Ingot Mould Sub-Committee an average mould life of 130 casts is to be expected, compared with an average of 100 for the standard composition.

MOULD-WEIGHT/INGOT-WEIGHT RATIO AND ITS RELATION TO MOULD CONSUMPTION

By N. H. Bacon, A.Met., F.I.M.

Synopsis

An examination has been made of the very comprehensive data provided by three Ingot Moulds Sub-Committee questionnaires (one pre-war and two post-war), and British Intelligence Objectives Sub-Committee Final Report No. 685, "German Ingot Moulds for the Casting of Steel Ingots." The data examined were for many types and sizes of moulds used in the various works in Great Britain and Germany, and from them the importance of the mould-weight/ingot-weight ratio in its relation to mould consumption has been established. Attention is drawn to the very large variations in mould-weight/ingot-weight ratio found within the United Kingdom and Germany, viz., in the United Kingdom 0·78 to 1·76 and in Germany 0·61 to 1·82, and possible reasons for such variations are suggested. A graph is given showing what appears from the data to be the optimum ratio for moulds of capacities of more than 18 cwt.

INGOT SURFACE DEFECTS: FORMATION OF "DOUBLE-SKIN" OR "CURTAINING" ON TOP-POURED MILD-STEEL INGOTS

By P. Walker

Synopsis

This paper describes work carried out to determine the cause of the surface defect present on top-poured mild-steel ingots and known as "double skin" or "curtaining." The results indicate that two factors are of significance: (*a*) trapping of deoxidation slag near the ingot surface during solidification, and (*b*) splash moving forward from the mould wall and allowing liquid steel to flow behind it. The former factor gives a "double skin" effect not visible on the surface, and the latter a visible "double skin" or "curtaining."

Discussion

Dr. L. Reeve (Appleby-Frodingham Steel Company) referred to the growth of statistical methods for the examination of works data and said it was a matter for satisfaction to see the growing tendency throughout the steel industry for the use of statistical methods. By a judicious use of statistical methods in conjunction with works experimental methods, i.e., controlled experiment under works conditions, a good deal of valuable information would become available which would be of great benefit to the steel makers.

Mr. W. H. Glaisher (B.I.S.R.A.), referring to the first paper, said that whilst statistical methods gave a great deal of information, there was one piece of information they did not show, viz., that the effect of phosphorus and silicon might not be the same with different compositions. The effect of phosphorus might be different with a high silicon content from that with a low silicon content. He had investigated the whole of the sixty moulds mentioned in the paper, of both compositions, and split them up into ranges of silicon below 1·5 and above 1·5 and had split each of these groups into various phosphorus contents and the information so obtained bore out what he had suggested. Unfortunately, it was not yet possible to say why silicon and phosphorus had these effects on moulds. It might be because of some effect on the micro or macro-structure or some effect on the mechanical properties. Any attempt hitherto to correlate life with micro or macro-structure had not been very satisfactory and further work was very desirable.

The effect of mould wall thickness on the ingot itself had not been discussed in any detail, but he had been through a great deal of the literature on the subject to find some concrete evidence to show that thicker walls produced more rapid solidification or vice versa, but had not been successful on the practical side.

Mr. H. A. Bevan (Guest, Keen, Baldwin's Iron and Steel Works) said the work which Mr. Kerlie had described had since set in motion a great deal more. He himself had tried low phosphorus and high silicon moulds, low silicon and low phosphorus and low silicon and high phosphorus, and endeavoured to get a comparison. Taking the results as a whole, there was a definite improvement in life with low silicon (about 1 per cent or less) and high phosphorus (about 0·2 per cent or even more). Actually, some moulds with 0·5 per cent phosphorus had the longest life.

The authors promised full replies in writing.

A very well attended lunch at the Dorchester Hotel followed. The toast of the "Iron and Steel Institute and Industry" was proposed by Sir Oliver S. Franks, Ambassador-Designate to the U.S.A.; Sir Andrew McCance, President of the Institution responded,; Lt.-Col. Sir John Greenly proposed the toast of "the guests," to which Lord Clydesmuir replied.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1.

PICKS, BEATER PICKS AND MATTOCKS

No. 1421 : 1947. This new standard prescribes the detail dimensions of eight implements, subdivided into twenty-eight weights and sizes, comprising :

Navvy picks with chisel and point and double-point ends ; beater picks with point and fishtail, and point and tee ends ; mattocks with point and mattock, cutter and mattock, and chisel and axe ends.

The variety and choice of picks and beater picks afforded should suffice for all normal usage by contractors, railways, municipal and other authorities. Mattocks also dealt with in the standard are an allied implement used mainly for cultivation overseas and are exported in large quantities. One important feature is that, for the first time, the eyes of such implements are standardised, thus facilitating manufacture for stock and the separate purchase of helves, the requirements and fit of which are specified. In addition, the standard deals with the quality of steel, tolerances on dimensions, hardness and testing, and has the approval of bulk users of such implements as well as of the Edge Tool Manufacturers' Association. Price 2s. each, post free.

CLINKER AGGREGATE FOR PLAIN AND PRE-CAST CONCRETE

No. 1165 : 1947. This standard has been revised to include an additional class of aggregate suitable for use in plain pre-cast concrete units where these are to be used for interior work not exposed to damp conditions. The additional class of aggregate, to be known as Class C, has a higher permissible loss on ignition than the classes included in the previous edition, which were suitable for use in plain concrete for general purposes and for interior work. The inclusion of this additional class has necessitated a change in title and, at the same time, minor amendments have been made to clarify the text and to include a modification of the soundness test to suit the new Class C clinker. Price 2s. each, post free.

UNIVERSAL DECIMAL CLASSIFICATION

No. 1000 A : 1948. This is the first abridgment of the full U.D.C. to be published in English, and is intended for use in libraries or private collections where detailed subdivision of subjects is not required, or in special libraries using the full classification in a given subject, but requiring an abridged classification for other fields. The complete fourth edition in English is being published by the British Standards Institution, section by section, and this abridgment should prove a useful introduction and guide to it. Price 25s.

QUALITY CONTROL

No. 600 : This Standard on the "Application of Statistical Methods to Industrial Standardisation and Quality Control," published in 1935, became established as a classical work on this subject. Unfortunately, during the war, the standing type was "blitzed," so the stock became exhausted and it was not possible to bring out another edition. The type has now been reset and once again copies are available. This Standard explains why a statistical technique is needed for the solution of problems of specification, standardisation and routine process control. Specimen problems are discussed to introduce the common statistical measures. Questions of sampling are examined and guidance on sampling is given. Methods of controlling the quality of a product are described, either by examining samples taken from batches or consignments or by routine testing in the course of manufacture. It shows how both methods can form the basis of the use of certification marks and includes statistical methods needed in industrial investigation. Price 12s.

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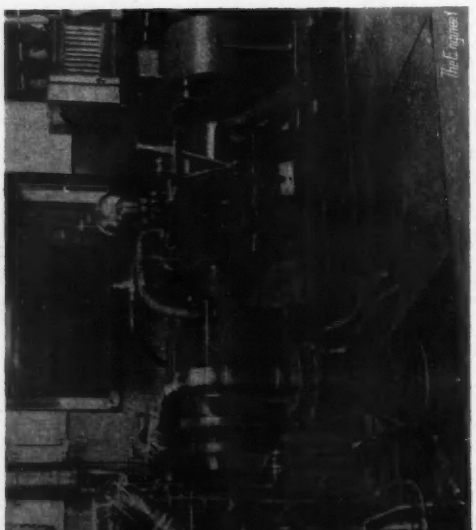
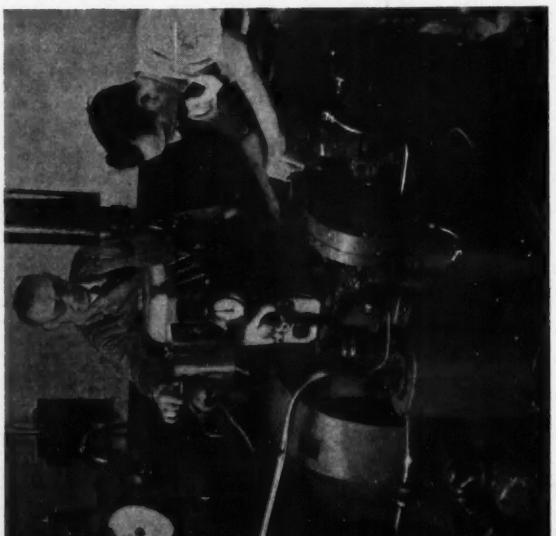
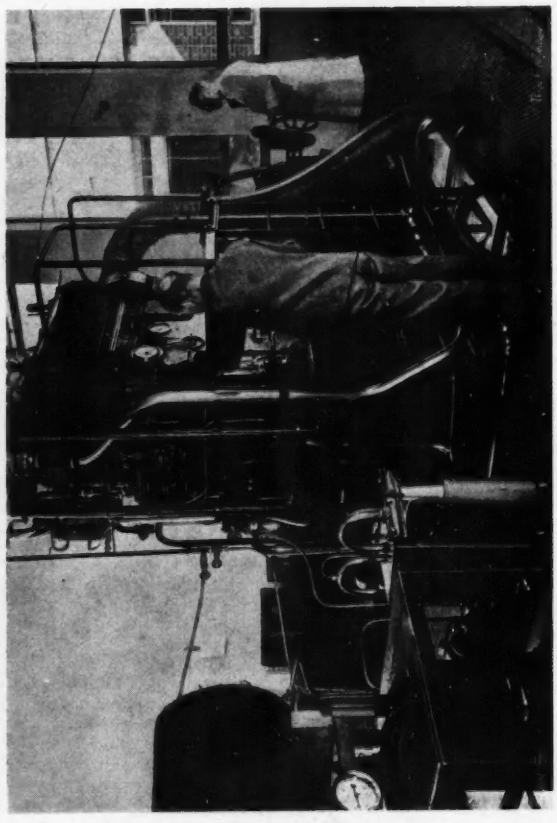




MERLIN SINGLE CYLINDER ENGINE ON TEST
ENGINE ON RING STICKING TEST



MULTI-CYLINDER ENGINE TESTING ROOM
TWO-CYCLE ENGINE TESTING HEAVY FUELS

Thornton Research Centre

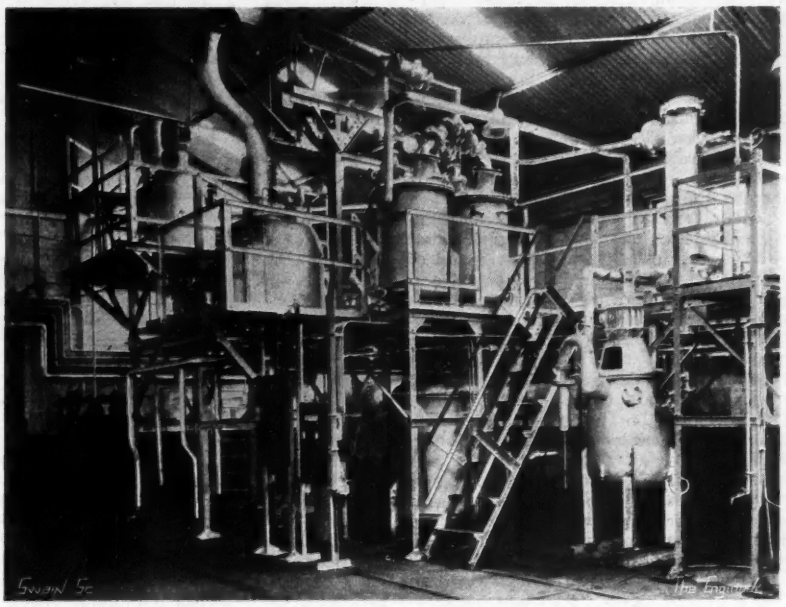
ON Thursday, May 20th, we were invited by the Shell Refining and Marketing Company, Ltd., to visit and inspect its Thornton Research Centre at Thornton-le-Moors, about 7 miles from Chester, and close to the company's Stanlow refinery, the largest in Great Britain. Over 200 guests took part in the visit, and they included leading officers in the Forces and representatives of the aero-engine, vehicle-engine and heavy-engine manufacturing industry. The new fuel-oil section of the laboratory was formally opened by Mr. George Legh-Jones, the managing-director of the Shell company, and that event was identified with the official opening of the whole laboratory.

In his address, Mr. Legh-Jones said that the new research centre was the largest and most up-to-date research establishment in the British Commonwealth. It would, he said, take its rightful place in the group of research centres of the Shell organisation, which included large laboratories and centres at Fulham, London; Amsterdam and Delft, Holland; Houston, Texas; Wood River, Illinois; and Emeryville, California,

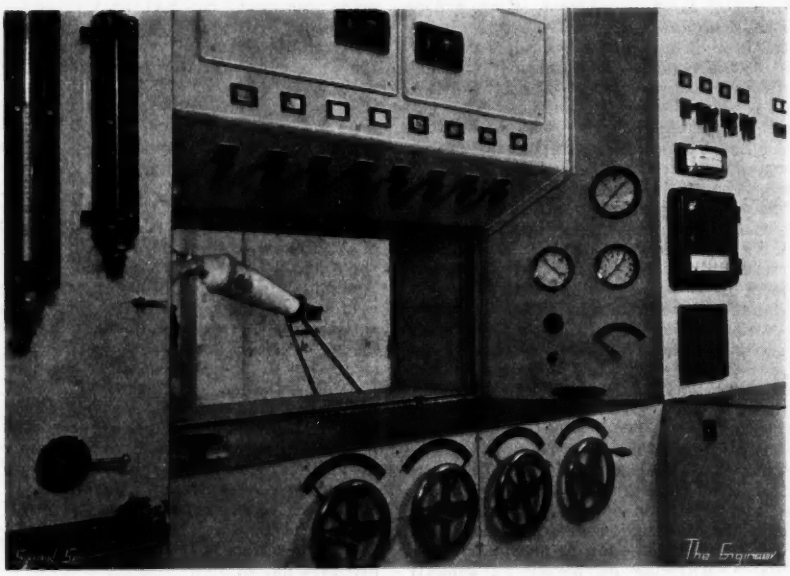
The Thornton Centre stands on a 30 acre site, and the laboratories have a total floor space of 730,000 square feet. No less than seventy petrol and oil engines are housed in the various sections, besides the large number of special laboratory rigs and appliances for work on a smaller scale. The staff numbers close upon 900, of which about 323 are qualified technical staff, such as scientists and research workers, while the remainder are occupied in the various technical services and administration, under the direction of Brigadier R. A. Bagnold, F.R.S.

The laboratory was started in the period immediately preceding the late war, when it was decided to establish at Thornton an aero-engine research laboratory with the object of keeping pace, by the development of petroleum fuels and lubricants, with the demand, by both designers and users, for more powerful, economical and reliable aero-engines. That laboratory was built and equipped in 1940, and it was in full operation by 1942. During the war it was placed at the free and entire disposal of the Ministry of Aircraft Production, and under a joint committee of the Ministry and the Shell organisation, a programme of research work was carried out. Assistance was also given to the War Office, in getting the valves of Service vehicles to stand up to the sudden heavy increases in the tetra-ethyl-lead content of the petrol, then supplied to the Forces. In 1943 it became necessary to expand the laboratory facilities both for immediate needs and with a view to post-war requirements and two new wings, one for chemical and metallurgical work, and the other for further engine test units were completed in 1945. Other laboratories were built and equipped for investigations connected with fuels and lubricants, the development of solvents and chemicals obtained from petroleum during the refining process, and pilot plants for industrial processes. All these laboratories were brought into operation in 1944. After the war the existing units were welded into one research centre under the control of a director of research. The work of the centre falls naturally into two main spheres of operation, the engine and the chemical divisions, and the new fuel laboratory just opened is the latest addition to the engine division.

Following the speech of Mr. Legh-Jones, Lieut.-General James H. Doolittle, the American Air Force Commander, expressed his great pleasure at being present. He reminded his hearers that as an air force commander who had operated in both western and eastern theatres of war, he had never been short of fuel supplies. Adequate supplies of the highest grades of fuel were, he said, of primary importance in any war effort.



PILOT PLANT FOR OIL ADDITIVES



TEST CELL IN THE AERO ENGINE LABORATORY

Four views in the various sections of the laboratories in the engine division are reproduced on the opposite page. In the new laboratory we saw the testing and calibration of injectors and fuel pump units on special rigs. Along with accurate measuring instrumentation use was freely made of the cathode-ray oscillograph. Other tests were being carried out on the corrosive properties of oil fuels, and in connection with these experiments, a valuable new form of porous chromium plating for engine liners has been developed. Other sections were working on exhaust gas analysis and problems of cylinder and piston wear. The influence of change in the ignition period and its effect on engine performance was also being studied In the single-cylinder room we noted engines by Rolls-Royce, Crossley, Dorman and Gardner, coupled to electric or hydraulic dynamometers with appropriate pressure and temperature measuring instruments.

We also illustrate a view in the multi-cylinder engine laboratory. In this laboratory work connected with all new design trends is being carried out, including the use of low-ignition fuels, pilot injection for both petrol and oil engines, and the use of heavier fuels in medium and large power engines. Among others, we noted A.E.C., Grey and other engine units. We illustrate the twin-cylinder Petter two-stroke engine, which is being used for experiments in heavy-oil fuels. Alongside that unit is a single-cylinder Allen engine, on which similar experiments are being carried out. Other sections of the laboratory were engaged on the study of additives, the influence of sulphur contents and engine liner and ring wear. We illustrate also the Fowler engine used for ring sticking tests.

Considerable interest attaches to the work going on in connection with aero-engines and gas turbine development. In one engine cell provision has been made for the accommodation of a complete Rolls Royce "Merlin" engine plant for the Tudor aircraft, complete with its lubricating and cooling equipment, which can be started and tested at temperatures down to −40 deg. Cent. In the gas turbine section we saw a "Goblin" combustion chamber rig, in which various gas mixtures can be tested. The unit is installed in a special room. Adjoining is a soundproof chamber with an observation window and all the necessary instruments and controls conveniently arranged. This unit is shown in the accompanying engraving. Experiments are also being conducted with a single-cylinder "Griffon" engine unit. Gas turbine fuels were being investigated in quartz flame-tubes, for the study of mixture strengths and associated problems.

In the lubricating oil section of the laboratory many engines were running and they include Caterpillar, Petter, Gardner, Crossley, and Fowler oil engines, and Bedford and Vauxhall petrol motors. In this section of the laboratory the work includes the investigation of wear problems and the effect of detergent and other additives. Such work embraces problems connected with steam engine piston-ring lubrication for which a Belliss and Morcom engine is being used.

In the metallurgical section a new method of increasing the life of valves by the deposition of a thin alloy film, using barium, nickel, chromium and aluminium as needed is being investigated.

In the industrial field, work is proceeding on the investigation of the properties of gear greases and their structure and manufacture for low and high speeds, on steam engine cylinder oils and on metal drawing and rolling lubricants. In the electrical industry section new oils for transformers, cables and capacitators are under test. The properties of aviation turbine oils are also being tested. In all these new fields new spectroscopic and X-ray examination methods have been introduced with good results, and these are being used along with the more normal analytical processes.

The work in the chemical section of the Centre is mainly concerned with the finding of new uses for the products and by-products of the refineries and with the production of solvents and chemicals from petroleum sources for industry. We noted several new paints and varnishes and the use of a petroleum extract for incorporating in natural and artificial rubber. A number of alcohols and ketones made from the cracking of paraffin wax are now successfully used as chemical solvents. Plasticisers for the plastics industry form another promising field and perfumes are being produced from petroleum bases.

An interesting demonstration was given of the new chemical soap replacer, "Teepol," which is used in several forms for the softening of hard waters. It forms a valuable addition to the dyestuff industry as a wetting agent.

In another laboratory we saw some of the larger apparatus which is worked in conjunction with the chemical sections of the Centre. By the use of pilot plants, one of which we illustrate, processes already worked out on a laboratory scale can be considered from the manufacturing angle. The plant shown and another made entirely in stainless steel for corrosive chemicals are used for producing batches of new materials such as alcohols and dopes for market exploration. One of the new oil additives is "Ionex," which has recently been produced in this country, for rust protection. Before the party left Thornton, Admiral of the Fleet, Sir John D. Cunningham, the First Sea Lord, thanked the company on behalf of the guests for the evident care which had been taken in arranging the many successful demonstrations, the generous hospitality given, and the excellent travelling arrangements made.

Telecommunications Research Establishment

AN exhibition of the work done by the Ministry of Supply's Telecommunications Research Establishment, Great Malvern, was held from May 25th to 27th, when the establishment was open to a number of scientists and representatives from the Services, universities and industry and, on the final day, to the public. The exhibition was declared open on Tuesday, May 25th, by the Minister of Supply, Mr. G. R. Strauss, who referred in a short speech to the origin, history and objects of the establishment, which, he recalled, was set up in 1935 to carry out research in telecommunications.

From its original strength of six research workers, the T.R.E. has grown to be one of the largest research establishments on the air side of the Ministry of Supply, and it now employs the full-time services of more than 300 qualified scientists. While it retains its wartime responsibility for the development of radio equipment for the R.A.F. and Naval Air Arm, the T.R.E. is now responsible also for the development of radio aids in civil aviation and for a programme of research in radio and electronics, part of which is sponsored by the Department of Scientific and Industrial Research.

The T.R.E. is organised, under its chief superintendent, Mr. W. J. Richards, B.Sc., into three main technical departments—radar, physics and engineering. Of these the radar department (superintendent, Mr. C. Holt-Smith, B.Sc., A.M.I.E.E.) is mainly concerned with developing radar and pulsed radio navigational aids for civil and military aircraft, and one of the main groups of exhibits was arranged to show the progress made in this field, particularly since the war.

For example, the Gee Navigation System was demonstrated in the form of the recently developed Mark III equipment, which will be used in civil aircraft. This set is a simply operated miniature airborne equipment, provided with a counting mechanism from which the aircraft position can be read on the lattice, which is produced by transmissions from Gee ground stations. Another series of exhibits showed how wartime Rebecca-Eureka (interrogator and beacon systems used for accurately dropping paratroops and supplies) have been modified and adapted to produce a distance measuring system for civil aircraft (Rebecca Mark IV and Eureka Mark IV). To indicate the progress made in air traffic control generally a model of a flying system was displayed, incorporating the following equipments—airfield control radar (A.C.R.), airfield surface movement indicator (A.S.M.I.), cathode-ray direction-finding (C.R.D.F.) and ground controlled approach (G.C.A.).

Although the ultimate aim of the radar department is the design of equipment to perform a specific function, this work depends upon substantial backing in the form of more fundamental research into new techniques. Thus, the generation of high-power pulses in transmitters presents problems which were typified in an exhibit showing an experimental modulator delivering an output of 5000kW in two microsecond pulses, recurring 500 times per second, and in a demonstration showing a method of paralleling magnetrons to produce a summation of their individual outputs.

The Physics Department, under Dr. R. A. Smith, M.A., Ph.D., A.M.I.E.E., is concerned mainly with fundamental research in radio and electronics. Its work, as shown in various exhibits, embraces research into the properties of very short waves, infra-red radiation, and some research on supersonics. The Physics Department includes a theoretical physics group, which is responsible for fundamental measurements and the maintenance of the station sub-standards.

Basic work on electronics was illustrated in the exhibition by the demonstration of a d.c. magnetic amplifier, which is primarily intended to work from low-impedance sources, such as thermocouples and is capable of detecting signal powers of the order of 10^{-17}W at frequencies below ten cycles per second. With this order of performance the equipment has many applications, not only in the field of industrial control, temperature regulation, but probably also in biological research. Another exhibit showed an electronic digital computer, which can "memorise" numbers and carry out mathematical operations in a fraction of a second. For example, the binary arithmetical unit can add together thirty-two digit binary numbers in less than 360 millionths of a second.

An interesting application of servo motors was embodied in a model of an automatic following telescope, similar to the installation which has been successfully demonstrated in Greenwich Observatory. This system makes use of a photo-sensitive cell and servo link to ensure that a telescope will follow a star automatically by night, without external assistance.

Two demonstrations were arranged to exemplify the work done on the detection of infra-red radiation. The first showed a thermocouple associated with a suitable amplifier to detect the heat from objects a few degrees above the surrounding air and situated several feet from the thermocouple. The second demonstration showed a lead sulphide photo-sensitive cell arranged to measure the heat generated locally by friction between two moving bodies in contact. This technique has been usefully applied to the detection of hot spots generated on the surface of a wheel during frictional braking. Although these hot spots are rarely visible, they can be detected by the photo-conductive cell and amplified to show the spots as short pulses of energy, the amplitude and duration of which can be measured.

Work on supersonics as demonstrated in the exhibition includes flow detection and absorption in metals with applications in the non-destructive determination of crystal structure; crack detection in concrete and stone and the detection of objects using ultrasonic waves in air.

An interesting exhibit in the nuclear physics field was the 15 MeV synchrotron—the equipment with which the principle of synchrotron acceleration was demonstrated for the first time. For the measurement of radio activity a number of "health monitor" instruments were shown, including portable beta and gamma monitors, a "pistol" monitor, beta counting equipment, a scintillation alpha counter and an integrating gamma monitor installation.

The Engineering Department, under its superintendent, A/Cdre. A. L. Gregory, M.B.E., M.C., provides the bridge between the work of the scientific staff and commercial production. Preliminary work on drawings and experimental equipment is carried out in drawing-offices and small workshops situated in each experimental block. The engineering unit carries out constructional work on the final experimental model, the full drawings being prepared in the main drawing-office. Another section of the Engineering Department is concerned with the preparation of parts lists, lists of spares and other documents essential to commercial production and to the satisfactory introduction of new equipment to the user.

An important part of the scientific effort of the Engineering Department is devoted to the investigation of new materials, finishes, and constructional methods, so that the finally assembled equipment can withstand the wide variations of temperature pressure and humidity associated with operating conditions in any part of the world. The establishment is also responsible for the packaging of equipments and spare parts to protect them from damage or deterioration by the climatic extremes to which they may be subjected in transit or in storage.

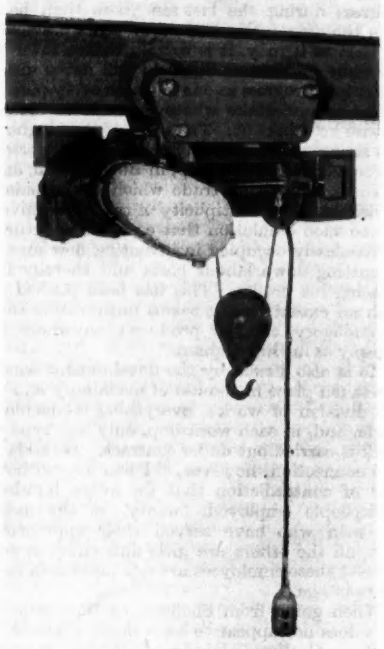
An Electric Hoist

We recently inspected a new electric hoist, which has been developed by R. D. Cardiff, Ltd., of York Way, London, N.1, and is now being made in eight sizes with capacities from 5 cwt to 5 tons. The general arrangement of one of these hoists, which are known under the trade name of "Hoistmaster," can be seen in the photograph we reproduce below.

In designing these hoists particular attention has been paid to reduce the necessity for maintenance to a minimum, and their all-steel construction combines in the hoists relative lightness with a high factor of safety. Ease of movement with the least possible degree of friction during operation has been obtained by mounting all moving parts on ball or roller bearings.

Four travelling wheels carrying the steel plate chassis of the hoist are mounted on wide, heavy-duty roller bearings, rotating on hardened steel axles. The makers point out that the chassis of each standard model is readily adjustable so that it can be adapted to fit in any of three sizes of joist.

The hoist drum is driven by a totally enclosed high-torque motor, through a roller chain and



"HOISTMASTER" ELECTRIC HOIST

worm reduction gear running in an oil bath. An electro-mechanical brake is fitted to give accurate control over movement, but the worm drive arrangement makes it impossible for the load to take control in the event of a brake failure.

The enclosed bottom block fitted to the hoist has a swivelling hook and is suspended on a non-rotating wire rope. The use of this type of rope avoids any tendency the block might have to rotate or twist when not under load. A guide meshing with the groove of the drum moves along with the rope to ensure its accurate lay during hoisting and lowering. An automatic hoisting limit switch is fitted to prevent over-winding and, if required, a lowering limit switch can be provided with the hoist. Another useful feature which can be supplied if required is a "quick splicer," which permits quick and easy renewal of ropes.

We are informed that all hoist models can be supplied for either fixed suspension, push travel, electric power or chain travel, with the exception of the 2 to 5 ton models, which are not arranged for push travel.

Gabriel Jars's Visit to Britain in 1764*

By M. JEAN CHEVALIER.†

A Journey from Scotland to Cornwall

The Treaty signed in Paris on February 10, 1763, put an end to a war which left both the United Kingdom and France similarly impoverished, but also both equally desirous of re-establishing promptly commercial relations indespensable to the prosperity of the two countries. In Paris, a main topic of conversation was the immense progress made, since the war, by British industry, and as soon as peace returned, the Government of Louis XV was most eager to send to England and Scotland an engineer to acquire some knowledge of the new processes. A man fit to undertake such a task was available. His name was Gabriel Jars.

From July, 1764, until September, 1765, for nearly fifteen months Jars resided in the United Kingdom. He did not set out on his round of visits before having learnt the language, so as to be in a position to profit by the explanations which were subsequently furnished to him everywhere with a kindness which stands to the credit of the industrialists of the period. In one of his reports he takes pleasure in giving praise to the eagerness with which owners of works, while witholding their professional secrets from their local rivals, furnish him with data—although he is not only a foreigner but a subject of a country which had only recently been at war with Great Britain.

Six reports spread between May 6 and September 6, 1765. inform the French Government of all that he has seen in the course of his journeyings.

Steam Engines and Railways

It is not intended to give anything like a detailed outline of these reports. Numerous passages are of interest to those only who make a special study of that particular period. Moreover, certain establishments which were in the front rank of British industries in the 18th century have now disappeared from the memory even of well-informed persons. New techniques which were then hardly established have subsequently become routine operations and have long since been abandoned. Again, industrial legislation on which the French Government desired a detailed report, dealing with such matters as the systems of royalties in mine operations, is too well known to English specialists to be worth quoting in this paper. We must, therefore, concentrate on the principal aim of Jars's journey, which was to ascertain how far the English had proceeded in the utilisation of coal; whether they had been able to substitute it for charcoal in the treatment of metallic ores; and whether they had found it necessary to reduce it to coke for such operations.

Two things particularly impressed Jars in his visit to the collieries at Newcastle, namely, the steam engines employed for pumping water out of the mines, and the railways. Steam engines were not unknown in French mines. The first of these—an atmospheric engine—had been installed in 1732 at the Fresnes Mine, near Condé (Dept. du Nord); a second had been installed in 1737 at the Anzin Mine and a third in 1749 at the Littry Mine. In Newcomen's own country, however, a "fire engine," as it was called, was to be found in practically every mine and these engines were of a power unknown in France. Pump engines having cylinders 50in dia. were by no means rare At the Walker colliery, near Newcastle, the first one seen by Jars, was a machine of 60in, and it was not the most powerful in that colliery. "The machine or fire engine of the Walker Colliery," he notes in his report of May 6, 1767, "is the largest in the north of England, and is perhaps the largest so far made in Europe. The cylinder has a diameter of 74in or 6ft 2in English measure[1] and a height of 10½ft. Its estimated weight is 13,000 lb. To furnish the steam required by this cylinder four large boilers are provided, three of which are always in service, the fourth acting as a standby. This engine is used to pump water from a mine which is 100 toises[2] (approx. 308 yards) in vertical depth, but it pumps the water from a depth of 89 toises only (roughly 200 yards) in three stages," The length of the piston stroke was 6ft, and the engine made from eight to twelve strokes per minute. The three boilers consumed 200 bushels of coal every 24 hours. The cost of the pump was between £4000 and £5000.

At Carron, near Falkirk, Scotland, Dr. John Roebuck had installed a steam engine at the top of each of his mines. They were engines having cylinders 50in dia. Two others were at Roebuck's Kinneil mines, seven miles from Carron, and a third was being erected. Jars, who had witnessed the Walker Colliery pump saw nothing out of the ordinary in these engines.

For us, however, they are of interest because they were the machines which were to teach steam engineering to a young engineer who arrived at Carron a few months after Jars; his name was James Watt.

The other innovation which held the attention of Jars was the new system of wagonways for conveying coal from the mines to the port loading berths. Jars gives these a whole chapter in his first report. He writes:

"An exact survey is made of the ground between the mine and the river and arrangements are made for the road to slope down all the way from the mine to the river. These roads must always be made to slope down; they must never go uphill. When the road, 6ft in width, has been laid out and the slopes decided upon, a ditch of the same width as the road is dug . . . . all along this ditch and across it, at a distance of 2ft to 3ft apart, are placed pieces of oak 4in, 5in, 6in and 8in square. These timbers need only to be squared at their ends, on which are fitted, by means of wooden pegs, other timbers carefully sawn or cut square and 6in or 7in wide and 4in to 5in thick. These pieces of timber are placed lengthwise throughout the length of the way and are usually fitted 4ft apart . . . The space between the pieces of timber is filled with stones," (Vol I, p. 200).

Wagons, the wheels of which are spaced the same distance apart as the wooden "rails" are used. When filled with coal they follow the slope of the track and descend without difficulty from the mine to the river.

The invention had a future before it. In 1767 an idea came to a Coalbrookdale ironmaster, Richard Reynolds, to replace the wooden longitudinals by cast-iron rails using metal tapped from his blast furnaces. In this manner the "wooden ways" became "iron ways."

In answer to the question regarding the price of coal, Jars writes that in Newcastle this amounted to 12s. to 15s. a "chaldron"[3]; in Edinburgh the price was 1s. 6d. per cwt. Miners were paid 1d. per cwt in Newcastle and they had to supply their own tools and candles. In the Carron mines they were paid 1½d. per cwt, and managed to earn up to 20s. per week while working only 7 to 8 hours a day.

The Use of Coke in the Blast Furnace

We come now to the reduction of coal into coke and the question of the aim of this treatment. Ever since Simon Sturtevant had suggested, in 1611, the substitution of pit coal for charcoal for the reduction of iron ore in the blast furnace, metallurgists, when endeavouring to work the process, had always come up against the impossibility of preventing the coal from caking when burning in contact with the ore. The mass of hot coal formed a scaffold or bridge across the furnace, preventing the descent of the charge above and also causing the iron previously reduced to be "burnt" by the blast.

According to the theory of combustion then prevailing—the phlogiston hypothesis enunciated by the chemist J. J. Becher—coal in

* Newcomen Society, December 10, 1947. Abridged.

† Président du comité nationale de l'organisation française.

[1] The French foot was 32·5cm = 12·8in English. (Translator's note).

[2] The toise = 6 French feet = 1·949m = 76·73in English (Translator's note).

[3] 36 bushels (O.E.D.). (Translator's note).

burning lost its phlogiston and this phlogiston "burnt" the iron, that is to say, destroyed its consistency.

A German named Blauenstein had suggested ridding the coal of its bituminous content and of its phlogiston by treating it in the same manner as wood is treated in the preparation of charcoal. The idea had come to him when he was living at Wednesbury and he had patented it under the name of Frederick de Blewston on October 25, 1677 (English patent No. 198). It was only in 1727, however, that Francis Wood (English patent No. 489) had succeeded at Whitehaven for the first time in making cast iron with the aid of dephlogisted coal in a reverberatory furnace, and tapping it. The process was so far from being perfect, however, that Swedenborg, writing in his *Regnum Subterranoum*, 1734, states that pigs made with Lancashire coke gave an iron which was so brittle that a bar made from it was invariably full of flaws and cracks.

In the matter of the treatment of the coal, namely, the process for ridding it of its bituminous contents which cause the fuel to cake when ignited, Jars found that two different processes were employed. The first was the time honoured method consisting of an imitation of the charcoal burner's stack. The second process was entirely new and he saw only one application of it, at Newcastle, quite at the beginning of his journey. At this plant the coal was distilled in ovens which Jars describes and illustrates. The installation comprised three batteries, each of three ovens. The distillation yielded an ashen-grey and very porous and light fuel, named "cinders." These cinders were chiefly employed for heating the drying kilns in which barley was transformed into malt for the brewing of beer. In all other areas the charcoal burner's stack method was employed and the product was called "coaks."

The coal best suited for the production of "coaks" at the Carron Ironworks was that named "clod" coal. A heap of this fuel 12ft to 15ft dia. was built up on the ground. It was 7in to 8in thick at the edge and 1ft 6in at the centre. It was ignited by a few burning coals and the whole was covered up with coal dust. The operation of conversion took about forty hours.

At the Clifton Ironworks, between Cockermouth and Whitehaven, coals from either of two seams of the mine, namely, "top" coal and "filling" coal, were employed.

"The operation of reducing pit coal to 'coaks'," states Jars, "is practically the same as that for converting wood into charcoal; a circle of from 10ft to 12ft dia. is filled with lump coal, but arranged in such a manner that air is able to circulate throughout the heap. The latter is conical in shape and 5ft in height. Straw is used as a covering, and on this earth and coal dust, to a thickness of at least 1in, are placed . . ." (Vol. I, p. 236.)

The Clifton furnace coaks were very porous and were much more like the Newcastle cinders than the Carron coaks.

"Coal prepared in the manner described," Jars goes on to say in his report on the Carron Ironworks, "is employed alone, and without any addition of charcoal, to smelt iron ore in two large furnaces standing next to one another. These furnaces are similar to those employed in Germany, and in several French provinces. I was told that they were 30ft high and oval in form in the interior, the major axis being 8ft. At each furnace there are two very strong ordinary leather bellows worked by a very large water wheel . . . . The flame coming out at the top of this furnace is so similar to that given out when pig iron is made with charcoal that it is impossible to note any difference. The process is also identical and the furnace is tapped every 12 hours, the yield of each tap being about 40 cwt. It is surprising to find that the pig made with this pit coal, which iron cannot in any way be used for making forgings, as will be dealt with below, can be so soft; that it can be filed and cut almost as easily as wrought iron, and this is a very considerable advantage when castings are made with the metal. Actually, the making of castings is the main object of this establishment." (Vol. I, p. 274.)

The Carron ironmasters, he adds, "find that the blast from their bellows is not sufficiently strong. They are having two new ones made and these will be of prodigious size. They will be 22ft in length and will incorporate pieces of oak at least 10in in thickness." (Vol. I, p. 277.)

The insufficient power of the blast, in fact, constitutes the "snag" in the reduction of ore by means of coke. These particular bellows of "prodigious size" still did not give sufficient blast and ten years elapsed before a blowing engine, capable of furnishing the requisite volume of blast for reduction by coke, was produced.

The coke gave an excellent foundry pig iron, but Jars notes that "pig made with pit coal is bad for producing wrought iron," He emphasises that it gives a brittle iron of poor quality. He confirms this at every ironworks during the whole of his journey. No one, so far, had succeeded in producing an acceptable wrought iron from coke pig iron. At Clifton furnace, foundry pig iron was made in the blast furnace with coke as the fuel, but the whole of the wrought iron came from charcoal-refined American pigs.

At the Workington works, "a blast furnace for producing exclusively foundry pig iron coaks is being built; the production of good wrought iron from pit-coal pig iron is considered impossible. This works contains the proof of this within its own area, since pit coal is obtained on the spot and the road for conveying coal from one of the mines to the ships passes in front of the foundry." (Vol. I, p. 250.)

With regard to steel, the answer both at Sheffield and at Newcastle is definite.

"The only iron which is fit for conversion into steel is Swedish iron; many experiments have been made with iron produced in England, but steel of such good quality has never been produced . . . . charcoal dust is the only material used for converting the iron into steel, and neither oil nor salt is employed." (Vol.I, p. 257.)

The method of steel manufacture involved is the cementation process in which iron bars are heated in contact with charcoal dust for five days and five nights in clay crucibles.

"The town of Sheffield," states Jars in his report of June 18, 1765, "is renowned for its file factories of which there are a great number. For making files, cementation steel is usually employed, i.e., raw steel after it has been treated under a tilt hammer but before it is forged. For all kinds of work on steel, the coal used is first rid of its bituminous fraction, as it is generally held that the bitumen in the coal is very harmful to steel, that not only does it increase the wastage or discard but that it actually spoils the steel. Hence, a large quantity of coal is placed on the forge-furnace hearth and air is blown on to it until the fuel is well alight and the flame and smoke of the bitumen have died down. The fuel is then removed and a little water thrown on to it to help to extinguish it. It is with this kind of 'coaks' or 'cinders' that articles of steel are forged; files also are forged with the 'coaks.'" (Vol. I, p. 259.)

Craft Associations or Freedom of Trade

The orders given to Jars on July 3, 1764, requested him not to fail to seek the causes of the United Kingdom's industrial development.

In France, Colbert had so regulated professional activities by statute that trade associations were more concerned with the maintenance of traditions and of trade secrets than with making progress in their crafts. It was so difficult for a man, who did not succeed his father, to gain admission to an established craft that he had no other resource than to join one of the sinecures that multiplied under Colbert's régime. Thus, the planned economy of the country entailed a disproportionate growth of state officials at the expense of the artisan class.

People were beginning to reproach Colbert for having made more laws concerning the factories than had been necessary to found the monarchy itself, and this multiplicity of regulations was looked upon as the primary cause of the decline of French industry. It is stated in the *Dictionnaire Universel de Commerce* of Savary des Bruslons, of 1760, that "craft associations have private laws which are nearly all opposed to the public good and to the intentions of the legislator. The first and most dangerous is that which erects barriers to industry by multiplying the costs and the formalities of admittance. The first principle of business is competition. It is only through competition that the arts are perfected, that goods are produced in abundant quantities, and that the State is able to obtain a surplus for export at cheap rates, thus fulfilling its main object, namely, that of occupying and feeding the greatest possible number of people."

By merely comparing the two centres, Sheffield, still subject to the trade-guild system, and Birmingham, in which freedom of trade prevails, Jars is able to demonstrate that unfettered competition is the source of prosperity.

"Sheffield is incorporated," he writes, "that is to say, her industries are split up into different trade guilds; a man who manufactures knives cannot make scissors; one who makes scissors cannot produce razors, and so on throughout the town's industries. No one can set up a business in the town unless he has acquired trading rights. This law, it is stated, has done immense harm to the town's commercial progress, but it is less felt, at the present time, because the leaders in the various industries have acquired wealth which enables them to carry on business on a large scale. It thus transpires that this town has witnessed greater progress during the last ten years than had been the case during the thirty years previous. Be that as it may, it is certain that a town in the same position as Sheffield will never make such rapid progress as one in which every person is free to undertake whatever trade or manufacture he thinks fit. The town of Birmingham is a striking example of this . . . . Any person whosoever is free to set up, in Birmingham, any business, factory or trade which he considers advisable. The multiplicity of trades has given rise to such emulation that each manufacturer is ceaselessly occupied in inventing new means of cutting down labour costs and thereby increasing his profits. This has been pushed to such an extent that it seems unthinkable that ironmongery can be produced anywhere so cheaply as in Birmingham."

He is also struck by the development which has taken place in the use of machinery and in the division of work; everything is machine-made, and, in each workshop, only one type of work is carried out under contract. He adds in this connection, however, "I can say without fear of contradiction that for every hundred workpeople employed, twenty, at the most, are men who have served their apprenticeship, all the others are girls and children and some of these employees are not more than four years of age."

When going from Sheffield to Birmingham, Jars does not appear to have made a detour to visit the Coalbrookdale Ironworks where Abraham Darby, by 1735, had brought to a successful issue the use of coke in the blast furnace. He does not seem to have visited Bridgnorth either, to inspect the works which John Wilkinson was bringing to completion at Broseley. He mentions neither of these works, and one must, therefore, conclude that he did not consider them particularly remarkable. In point of fact, it was only in 1772, seven years after Jars's visit, that John Wilkinson was able to increase the weekly output of his coke blast furnace from 10 to 20 tons.

Jars returned to France with the title of Associate Member of the London Royal Society of Arts, and on August 30, 1768, the Government requested him to visit Burgundy, Franche-Comté, Alsace, Lorraine and Champagne to inspect works and to instruct leaders of industry in all matters likely to improve their methods.

One of his very first visits is to the Creusot colliery. He teaches the management the method of reducing their coal to coke, and counsels them earnestly to use the resulting coke for the manufacture of iron in the blast furnace. Not only does he dispatch a very warm report in reco mmendation of the request for a concession sent in by the mine authorities but, in addition, he especially calls the Minister's

attention to the situation at Le Creusot, which is particularly suited for the installation of coke blast furnaces " to serve as models in the kingdom in which timber is getting scarcer while the consumption of iron and steel is daily increasing."

With the object of helping on matters, the essential portions of Gabriel Jars's reports were published by his brother between 1774 and 1781, in three volumes, bearing the title *Voyages métallurgies, ou recherches et observations sur les mines et forges de fer, la fabrication d'acier, celle du fer blanc et plusieurs mines de charbon de terre, faites depuis l'année* 1757 *et compris* 1769 *en Allemagne, Suède, Norwège, Angleterre et Ecosse.*[4]

In the first volume, issued in 1774, is reproduced Jars's fourteenth report (pages 325 to 333), that published in 1769 and dealing with the *Manière de prèparer le charbon mineral autrement appelé heuille, pour le substituer au charbon de bois dans les travaux métallurgiques.* The method described is the classical one of the charcoal-burner ; from 5 to 6 tons of coal are arranged in a heap, 10ft to 15ft dia., in such a manner that the mound is 2ft in height in the centre. On top of the heap is placed a layer of straw and on top of the straw is shovelled earth to a thickness of 1in. The heap is ignited and slow combustion allowed to continue for four days, after which the fire is extinguished and some twelve hours later the coke, the yield of which is equivalent to 65 per cent of the original coal, is raked out. A gang of three men can thus produce from 35 to 40 tons of coke a week.

Jars, however, had left no notes regarding the production of iron from coke, other than the report of his comparative tests carried out at St. Etienne five months before his death. Marchand La Houlière realised that de Genssane would be no more successful in making cast iron with coaks at Alais than he had been in using cinders at Hayange. In these circumstances the only thing to be done was to go once again to England to learn the method used there.

It was chiefly to the Staffordshire mines and ironworks, of which Jars had said little or nothing, that La Houlière turned his attention during a visit in July and August, 1775. He saw at the Francis Wood mines at Wednesbury, eight miles from Birmingham, a Newcomen engine which was even more powerful than that which Jars had admired at the Walker Colliery at Newcastle. Its cylinder was 76in dia., while another at the same mine had a cylinder 54in dia.[5]

He visited John Wilkinson's works at Broseley in which was to be seen the famous gun and cylinder-boring machine.

Wilkinson had at last found the man capable of supplying what ironmasters had been seeking for twenty years, namely, a blowing engine powerful enough to render coke blast furnaces capable of yielding the same quantity and quality of pig as that tapped from charcoal blast furnaces. This man was James Watt, who had then recently left the Carron Ironworks after Roebuck's bankruptcy, and had joined forces with Matthew Boulton, a button manufacturer of Soho, Birmingham. In order to fit the Newcomen engine with the improvements which he had patented, Watt needed accurately bored cylinders which only Wilkinson could produce. Watt's improvement, comprising a separate condenser and a closed cylinder, turned the Newcomen engine from a mere water pump into a blowing engine powerful enough to supply a blast furnace with all the blast necessary to work the coke-reduction process.

Watt had placed an order for cylinders with Wilkinson, and the latter, in turn, arranged to secure the first steam engine to be made at the Boulton and Watt Soho Manufactory, for the purpose of blowing his blast furnaces at Broseley.

[4] Jars's premature death precluded him from preparing his Reports for publication. His brother, in doing this work, re-arranged the material but made little change in the wording, e.g., those paragraphs above that are inset and followed by a page number are almost literal copies.

[5] La Houlière's reports are in Files F12 1300 and F14 4261, in the French Archives Nationales.

The meeting of these two men in 1775, although little remarked upon, was to change the face of the world. Up till that time the iron industry had been a seasonal one, it being dependent on water-power streams ; the volume of water was sufficient to turn the mill wheel, working the bellows, for little more than six winter months in every year. The adoption of coke and also of the steam engine for blast-furnace operation transformed it into a continuous industry which, from then onwards, was free to develop without any dependence on timber reserves or the depth of water in streams.

La Houlière made a deal with Wilkinson for the establishment, in France, of an iron foundry run on English lines. Wilkinson saw in the arrangement not only an advantageous business deal but also an occasion to get rid of his brother William, the manager of his foundry at Wrexham, who was proving a most difficult partner.

William Wilkinson arrived in France in November, 1775, and put down in the island of Indret, near Nantes, a foundry for remelting old cast-iron guns which were encumbering French arsenals. Two million francs were spent in this way before the primary object of the scheme, namely, the erection of coke blast furnaces, was embarked upon. In 1779, fifteen years after Jars's journey through England, France was still awaiting her first coke blast furnace. It was then that the Minister for the Navy decided to send to Indret Captain F. I. de Wendel—who had been present when Jars, Stuart and Genssane had conducted their experiments—for the purpose of reporting on whether Wilkinson's continued stay in France would serve any useful purpose.

After investigating the whole question, Capt. F. I. de Wendel undertook the complete responsibility for carrying out the entire programme sketched out by Jars. Moreover, he wished to accomplish this at Le Creusot, the very locality indicated by Jars where, in 1775, Stuart had inaugurated the first French company to devote itself to the production of iron using coke as fuel.

On April 7, 1780, the Government granted F. I. de Wendel the Indret works on a fifteen years lease, with the proviso that he build the requisite blast furnaces from his own resources. F. I. de Wendel immediately secured the collaboration of William Wilkinson " for the purpose of constructing the plant necessary for smelting iron ore by means of sulphur-freed pit coal in a furnace, and to convert the resultant pig into wrought iron by a reverberatory process according to the methods actually practised in England."

These establishments became the Creusot Royal Foundry, which incorporated the most remarkable equipment of the period, including four blast furnaces designed by Wilkinson and each 39ft high (the height for charcoal furnaces being only from 20ft to 26ft high) ; also between 5 and 6 leagues[6] (20km to 24km) of railways for conveying coal from the colliery to the treatment stage of the blast furnaces, and seven steam engines. These comprised three steam pumps at the collieries, three blowing engines for the blast furnaces and a " rotative " engine, the very first of that type produced by Watt and used to work the hammers in the forge shop. Other equipment included a gun-boring machine, another for boring cylinders up to 6ft dia. and several forging plants.

The creation of such an important establishment needed considerable capital which ordinary financiers could not supply. The Manufacture Royale du Creusot was, therefore, turned into a share company having a capital of ten million francs spread among 4000 shareholders, King Louis XVI taking up one-twelfth of the capital. On November 10, 1786, the General Assembly incorporated into the company the Indret Foundry and the fine-glass works erected at Le Creusot.

The use of pit coal, the adoption of steam in place of the forces of nature, the concentration of capital and the sub-division of labour ; these four modern tendencies were thus brought together for the first time in a single undertaking which gave employment to 1000 workmen.

[6] French *Lieue* = 4 km. (Translator's note).

The Creusot blast furnaces were tapped for the first time on December 11, 1785, and this constituted the birth of modern heavy industry.

Gabriel Jars played a pre-eminent rôle in the industrial revolution which substituted coke for charcoal, the steam engine for the millwheel, and put man in the possession of all the iron he required for the construction of any machine which his brain could conceive. Jars can be likened to a busy bee which brought back the honey of progress, gathered from mines and ironworks throughout Europe, to the hive of French industry. In rendering him homage, we pay tribute also to many British engineers and technicians, some of them renowned, others quite unknown, who were the originators of these improvements, and who judged that it was in the interests of all mankind to spread their knowledge throughout the world.

South African Engineering Notes

(By our South African Correspondent)

Union's Coal Resources

A survey of the Union's coal resources shows that with an annual output of about 25,000,000 tons, valued at close on £8,000,000, of which an increasing amount is being sent overseas, South Africa has recently become one of the world's main coal-exporting countries.

A publication of the South African Interests Group (Incorporated)—a body interested in the study of social and economic questions—giving this information, goes on to say that there is a lack of true coking coals, so important for the steel industry. So far, only in Natal have two areas been discovered with reasonable reserves, and, in view of the great national importance of coking coal, a special Government Commission is at present investigating the position.

Coal reserves are enormous, though generally of a poor quality, but the costs of exploitation are considerably lower than in either Europe or America. This gives the oil-from-coal industry a very considerable chance for successful operation. It can, therefore, be confidently stated that the Union need not fear shortages in her future coal supplies, except possibly in coking coals, if the obvious remedies are not soon applied.

The only deposits in the Cape are thin, shaly seams, and the limited production amounts yearly to 3000 tons of inferior coal for local consumption. Nearly the whole of the Free State is coal bearing, but only towards its northern boundary do the seams become of commercial importance. This field extends into the Transvaal. Lack of prospecting makes it impossible to estimate coal reserves with any accuracy, but it may be stated that, with an annual output of 5,000,000 tons, the life of this field should last for 1000 years.

Official estimates put reserves in Natal at 150,000,000 tons of bituminous coal and at 50,000,000 tons of workable anthracite. Unfortunately, the bituminous coal occurs in six separate mountains. It is doubtful if any new collieries could operate in this area, but some of the existing collieries have a considerable life.

The appraisal of the quantity of usable coal is much more difficult, but there are indications that this highest quality coal is being rapidly worked out.

The available coal resources of the Witbank-Middelburg district of the Transvaal are estimated at several hundred million tons of good quality, general-purpose coal, and at thousands of millions of tons of lower-grade material. Further reserves are probably available at Breyten-Ermelo and Hendrina, besides the area between Bethel, Standerton and Piet Retief.

Other fields of less immediate importance, but of probably great future interest, are the South Rand coalfield, between Balfour and the Vaal River, and the Springbok Flats and Zoutpansberg fields.

Shipping coal comes from the best quality Natal and Witbank sources, while power generation draws principally on the Vereeniging area.

Industrial and Labour Notes

British Overseas Trade

The Board of Trade Accounts, which were published at the end of last week, show that the value of United Kingdom goods exported in April was £126,358,082, compared with £120,958,075 in March. Allowing for the rise in prices since 1938, the volume of exports in April—in which there were twenty-six working days—is provisionally estimated at 132 per cent of 1938, compared with 129 per cent in March and 126 per cent in the first quarter of this year.

A prominent feature of the April figures is the increase compared with March, in machinery exports. The total quantity exported was 70,482 tons, which was 184 per cent of the 1938 monthly average. Vehicle exports in April made a further notable contribution, the number of motor cars sent overseas being 18,366, and of commercial vehicles 6634, both of which figures were the highest on record. Exports of new merchant ships were 80 per cent above the 1938 monthly average, although they were 25 per cent lower than in March. Exports of iron and steel and manufactures thereof totalled 157,012 tons, and were much the same as the 1938 monthly average. Coal exports in April amounted to 733,862 tons, compared with 27,033 tons in April, 1947, and a monthly average of 2,988,019 tons in 1938.

Imports in April were valued at £186,172,083, and thus exceeded the previous highest post-war total of £179,248,032 reached in July last year. As the value of re-exports was £5,340,577, the adverse balance increased in April to £54,473,424, the biggest since September last year. This, the Board of Trade says, is accounted for partly by the continued unfavourable movement of prices. Since the end of last year import prices have risen by as much as 5 per cent, while export prices have increased by not more than 2 per cent.

At the beginning of this week the Treasury issued an explanation of the increase in the adverse balance, stating that a distorted picture is obtained by comparing exports c.i.f. with exports f.o.b. Most of our imports, the Treasury points out, are carried in British ships and the freight on them is not a charge on our balance of payments. Even if only the conventional 10 per cent of the gross figure is allowed as the cost of freight and insurance and is deducted from the published figures, the visible deficit in the period January to April this year is reduced from £174,000,000 to £107,000,000 and that for April from about £54,000,000 to £36,000,000. The Treasury's explanation adds that the big increases in imports have been principally of the kind which does not involve any direct drain on our gold and dollar reserves.

Purchase Tax Policy

The Engineering Industries Association is making representations to the Government on the subject of the present purchase tax policy, which, it is claimed, is seriously jeopardising the future of the whole of the British engineering industry.

The Association contends that the constant fluctuations of purchase tax constitute one of the most serious obstacles to efficient planning for production, and says that forward planning is impossible when "literally overnight price increases are imposed, perhaps to be removed some months later." In the Association's view, engineering executives in this country dare not plan ahead to-day as "the confidence of the whole industry has been shattered. If a firm undertakes market research, installs new tools, purchases material and engages labour to produce a new line, all that time and money may be wasted by the reckless imposition of purchase tax on the article overnight." The effect of this, the Association asserts, is not only felt by the manufacturer of finished goods, but by everyone from the tool maker to the finishing processor.

Recent experience seems to show, the Association concludes, that the tax is imposed almost at the whim of the economic theorists who may or may not be overruled when industry points out the effect of it. Only the Government can put right so deplorable a state of affairs and thus regain the confidence of the engineering industry.

Guest, Keen and Nettlefolds, Ltd.

Proposals for increasing the authorised capital by £3,000,000 to £23,000,000 have been announced by the Board of Guest, Keen and Nettlefolds, Ltd. The proposals are set out in a circular to shareholders, which says that the directors have for some time past been considering the general position, both in relation to the structure of the undertakings of the company and its subsidiaries as a whole, and also in relation to the problems which may be expected to arise if the iron and steel industry is nationalised. For administrative reasons, the directors feel that it would be advisable to make the company entirely a holding company and to carry on the operative parts of the undertaking through separate subsidiary companies.

This policy, the circular explains, has also been decided upon in view of the possible nationalisation of the iron and steel industry. The directors make it clear, of course, that they have no knowledge of the details of the nationalisation scheme which is reported to be under consideration by the Government. They feel, however, that the problems for the company which would arise on nationalisation are likely to be considerably simplified if steps are taken to separate those operative parts of the undertaking likely to come within the scope of iron and steel nationalisation.

The A.E.U. on Union Practices

The monthly journal of the Amalgamated Engineering Union has commented, in its latest issue, on the recent debate in Parliament on the Monopoly Bill, and has expressed concern that the President of the Board of Trade and the Lord President of the Council should consider that the question of union practices was still open to enquiry. It is suggested by the A.E.U. that the matter of trade union practices and customs is already adequately dealt with by existing legislation.

The journal recalls that, to assist the mobilisation of the nation's resources in manpower and industrial equipment just before the war, and to permit no impediment to stand in the way of full production, the A.E.U. took the initiative in relaxing established customs. By so doing, it is claimed, the union gave up many important safeguards of its members' interests in the engineering shops; safeguards affecting skilled crafts, dilution of labour, overtime, wage scales, the position of trainees, demarcation problems, and the performance of skilled operations by unskilled or semi-skilled labour. For every one of those workshop practices and rules, the A.E.U. says that it could and would make a strong fight as it considers them "necessary measures for the protection of its members against exploitation in periods of trade depression, short-time employment, wage-cutting, and the sometimes stupid autocracy of employers and managements."

The A.E.U. journal reveals that in relaxing these pre-war customs of the workshop the union took the precaution of having every departure from rules and customs recorded. Its system of registration was generally adopted by other unions and all the changes made were covered by a Government pledge and employers' promises that the unions could claim the restoration of pre-war practices when the war terminated. Legislation embodying the Government's pledge was enacted, and, originally it was intended that it should take effect from December 31, 1947, but by agreement between the Government and the National Joint Advisory Council, it was decided to postpone the date for one year. Automatic restoration of pre-war practices is not envisaged, but the A.E.U. observes that "the only doubt in its own mind is whether the unions should not now insist upon bringing the Restoration of Pre-War Trade Practices Act into immediate operation."

Trade Associations and Prices

During his chairman's address at the recent annual meeting of Johnson and Phillips, Ltd., Mr. G. Leslie Wates made some reference to the work of trade associations in which, he said, there was much virtue which should be known. The test of any trade association should be the answer to the simple question: "Is it harmful to the community?"

Various public statements, Mr. Wates thought, made it appear that in some quarters competition in prices was supposed to be the solution of all problems of trading. He suggested, however, that if there was a reasonable and proper price fixed which showed a fair margin of profit to the efficient trader, there would certainly be competition in quality, which was all to the benefit of the customer. Moreover, such competition in quality was the best possible stimulant to efficiency in the factory. Unnecessary selling expenses might well arise where there was competition in prices, but competition in quality was a matter from which nothing but good could come.

Mr. Wates also said that a strong, virile home trade was essential to support an export trade, which in its turn was vital to the continued life and health of the country. Cut-throat competition in prices inevitably resulted in a lowering of the standards of quality, and that would be of no help to the export trade. If, however, we had competition in quality, so that we produced the very best article of its kind that the world could make at a fair price, we should find that the world would come to us for that article.

A New Factory for Glass Bulbs

There was recently registered a new company under the title of Glass Bulbs, Ltd., with an authorised capital of one million pounds, which will be subscribed equally by the British Thomson-Houston Co., Ltd., and the General Electric Co., Ltd. This company proposes to build and bring into operation as quickly as possible a new factory with a potential annual capacity of over 400 million bulbs of the types used for making electric lamps and radio valves. A site for the new factory has been chosen at Harworth, near Doncaster, where two "Ribbon" machines of the type developed by the Corning Glass Company, of America, will be installed. It is stated that the new company will make all types of bulb components available to all manufacturers in the lamp and valve industries.

Since the war the supply of bulbs, which many users imported into England up to 1940, has been cut off, and the glass factories of the B.T.H. and G.E.C. have had difficulty in fulfilling the growing demands for their products. This difficulty in keeping pace with the demand has increased, despite the fact that the considerable reserve capacity which the existing factories had in 1939 has been fully developed. It is pointed out that the new specialised factory will produce bulbs more economically and will allow for the development of a considerable export trade of bulbs in addition to lamps. Its introduction will also allow the older factories to devote a large part of their capacity to making domestic glassware, of which there is a great shortage. With the existing delays in building machines and premises production is not expected to start until the end of 1949 at the earliest.

French Engineering News

(From our French Correspondent)

The Monnet Plan Commissioners have announced that the Electricité de France has fulfilled its first six months' 1947 production quota 100 per cent. It is also expected that figures will show that for the whole year the goal of 26 to 27 milliard kWh will have been achieved. Nevertheless, there is still an overall shortage of electricity and restrictions will again have to be imposed in 1948, in spite of the starting of the Génissiat plant.

Hydraulic plant put into service for the first six months of last year represented 524,000,000 kWh. Hydraulic plant completed during the second six months represented an increase in production of 339,000,000kWh and new thermal plant production over the same period amounted to 104,000kWh.

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The heavy industries at the Paris Fair are something of a disappointment this year. There are relatively few novelties, although Switzerland and Italy are better represented than ever. British firms once again hide behind French names. The Americans appear to be much more in evidence because they either have French offices or they insist that agents should use their own names. This may have its advantages. Business, your correspondent understands, has not been particularly brisk, although there have been many inquiries. British firms are up against the import licence problem. The Government should, indeed, try to negotiate the lowering of these walls which are stifling international trade.

Industrial Exports, Ltd., which combines a series of British firms including Armstrong Siddeley, Furzehill and Scophony, could have done very brisk trade. The Armstrong Siddeley air-cooled diesel engine excited considerable interest, but orders could not be taken because of import restrictions.

Your correspondent visited stand after stand and was always told "delivery in 1949." That is very disheartening. Bernard, for example, have produced a new diesel four-stroke, four-cylinder 50/70 h.p., 1700 r.p.m. diesel engine. It offered no particular novelty, but looked robust and would sell very well indeed; but deliveries cannot be made this year.

O.N.E.R.A. (Office National D'Etudes et de Recherches Aeronautiques) has done some good work over the past year. This stand included some interesting instruments. An instrument for detecting minute metallic objects deeply buried was worth examination because of its great sensibility. Altogether on this stand there were about twenty-one different instruments, most of which had some novelty. There was a good selection of welding machines, many of which are standardised, showing that the Standardisation Committee has been doing good work. Production should benefit from this trend, as well as price.

* * *

Monsieur Marcel Flouret, president of the administrative council of the S.N.C.F., has stated that in 1948 the railways expect to spend 61,500 million francs for construction and the purchase of new rolling stock. This figure compares with 63,700 million francs in 1947, and if the considerable rise in prices is taken into account, it is obvious that there will be an appreciable reduction in the work which the S.N.C.F. can undertake. The reduction will amount to 40 per cent and will mean the postponement or slowing down of work which is of importance to the country, such as the electrification of lines. Purchases of new rolling stock will also be curtailed, although the general state of wear and age of present rolling stock makes renewal necessary.

It is pointed out that the Marshall Plan envisages the construction, between 1948 and 1952, of 43,100 goods trucks and the importation of a further 28,700 units. The S.N.C.F. envisages the order of 15,000 covered trucks, both tipping and flat, shortly.

Notes and Memoranda

Rail and Road

NEWLY PAINTED EXPERIMENTAL TRAINS.—The Railway Executive has announced that during the summer fourteen main line and cross-country express services will be worked by trains painted in experimental colours. The routes have been specially selected so that the trains may be seen by as great a number and as large a cross section of the public as possible. The colours selected are as follows:—most powerful express passenger engines, blue with lining of red, cream and grey; other express passenger engines, green with lining of red, cream and grey; mixed traffic engines, black with lining of red, cream and grey; freight engines, black; main line corridor trains, plum and spilt milk lined with bands of yellow-maroon-yellow separated by lines of spilt milk, and chocolate and cream lined with black and golden yellow; local suburban steam trains, maroon lined with golden yellow-black-golden yellow; and multiple-unit electric coaches, green. The public is invited to express in writing its opinion on the experimental colours of the locomotives and carriages. Letters should be sent to Box A, the Railway Executive, 222, Marylebone Road, London, N.W.1.

CENTRAL LINE EXTENSION TO HAINAULT.—London Transport states that the section of the Central Line between Newbury Park and Hainault is to be opened for passenger traffic on May 31st. The new section, 1·89 miles in length, has already been in use since December, 1947, when the line was extended from Leytonstone to Woodford and Newbury Park, for running empty stock to and from Hainault depot, which now becomes one of the two main depots at which all Central Line rolling stock inspections and minor repairs will be carried out. The other depot will be at the western extremity of the line, at West Ruislip, when the electrification of the section beyond Greenford is completed. Repairs of a major character will continue to be carried out at London Transport's rolling stock overhaul works at Acton. Hainault depot is now being modernised and rehabilitated after its wartime use by the War Office and also by the United States Transportation Corps, who used it for the assembly of rolling stock in connection with the operations in North-West Europe. When this work is completed the depot will have a total capacity of 344 cars, of which approximately one-fifth will be under cover. The former Eastern Region tracks have been reballasted throughout by London Transport, which has also installed the current rails and power supply. London Transport's standard form of signalling, with two-aspect colour-light signals, has been installed with some modifications to suit the steam goods working of the Eastern Region, which will continue at night. The bringing into service of the line to Hainault completes the electrification of the southern half of the Fairlop Loop. The northern half, from Hainault to Woodford via Grange Hill, Chigwell and Roding Valley, will be completed at the same time as the electrification of the line from Woodford to Loughton, i.e., at about the end of the year.

Air and Water

HANGAR PROGRAMME FOR LONDON AIRPORT.—A ten-year hangar-building programme at London Airport was referred to by Lord Nathan, Minister of Civil Aviation, in a recent address to the Society of Licensed Aircraft Engineers. He said that, whilst the whole scheme might take ten years to fulfil, the programme for the next five years had been based on the assumption that the four existing wartime hangars would continue to be used to their maximum capacity and, by 1953, B.O.A.C. aircraft on the Atlantic and Empire services would all be based at London Airport. It was hoped that within this period of five years the whole of the B.S.A.A. fleet would also be based there, and a percentage of the B.E.A. fleet.

GAS TURBINE SCHOOL.—On May 31st twenty engineers are to begin a three-weeks' course at Britain's School of Gas Turbine Technology at Lutterworth. The school is housed in the buildings where Air Commodore Frank Whittle carried out many of his early experiments. The school was originally founded in 1943 to instruct Dominion Air Force engineers in the basic facts of the jet engine, and later the syllabus was extended to include civilian engineers. In July, 1946, the National Gas Turbine Establishment took over the school at Lutterworth, and it was not until March of this year that it was returned to Power Jets (Research and Development), Ltd. The present industrial course is to be followed on June 28th by a two-weeks' aero-engine course. The programme for this year includes nine courses, which vary in duration from two to three weeks, and will cover industrial uses and aero-engines in addition to an international course. The latter is a combination of the industrial and aero-engine syllabuses. At present all courses are designed for graduate engineers, but the company intends to organise practical classes for testers, engineers, operators and engine fitters. To provide students with a working knowledge of the gas turbine and its possibilities it is hoped to run courses during the holiday periods for a limited number from universities and technical colleges.

NAVAL AIRCRAFT FOR INTERNATIONAL AIR EXPOSITION.—A composite squadron of representative naval aircraft embarked on May 25th in H.M. Canadian Aircraft Carrier "Magnificent" for Canada *en route* for New York, where the squadron will take part in the International Air Exposition from July 31st to August 8th. The squadron consists of two Sea Furies, two Sea Hornets and one Sea Vampire, which is a "jet" fighter. H.M.C.S. "Magnificent" has recently been completed for the Royal Canadian Navy and is making her first voyage to Canada.

Miscellanea

FIREDAMP DETECTORS.—The Minister of Fuel and Power has made the Firedamp Detectors (No. 5) Order, 1948, approving the Ringrose Automatic Firedamp Alarm, type 47/125, as a type of detector for the purposes of the Coal Mines General Regulations (Firedamp Detectors), 1939. The Order came into force on May 3rd and the approval is subject to certain conditions.

INSTITUTE OF BRITISH FOUNDRYMEN.—Mr. J. J. Sheehan has been nominated as Junior Vice-President of the Institute of British Foundrymen for 1948–49. The Council of the Institute has made the following awards for 1948:—E. J. Fox Gold Medal to Mr. J. G. Pearce, in recognition of his services to the foundry industry during the years in which he has been Director of the British Cast Iron Research Association; the Oliver Stubbs Gold Medal to Mr. L. W. Bolton, formerly Secretary and President of the Birmingham branch; and the Meritorious Services Medal to Mr. C. Lashly, in recognition of his services as Honorary Secretary of the Newcastle-upon-Tyne branch.

ENGINEERING ASPECTS OF ATOMIC ENERGY.—A school for graduate training in the engineering aspects of atomic energy is being established in the production plants of the Atomic Energy Commission which are operated by the Carbide and Carbon Chemicals Corporation at Oak Ridge, Tennessee, U.S.A. The school, it is stated, is being set up by the Massachusetts Institute of Technology for its own engineering students. The purpose of the school is to train students in several aspects of engineering practice under a programme designed to develop their ability to apply basic principles to the solution of technical problems, with particular emphasis on the engineering aspects of atomic energy.

THE N.P.L. "OPEN DAY."—The National Physical Laboratory at Teddington is holding an "Open Day" on Monday, June 21st, from 2.30 to 6 p.m., to which representatives of industrial organisations are being invited. The wide range of scientific research and investigational work undertaken at this establishment is already well known to industry, but it is felt that there may still be a large number of firms with which the N.P.L. has no contact. Some of these will undoubtedly wish to take the opportunity of seeing the scope of the Laboratory's activities and some invitations are being reserved for this purpose. Accredited representatives of industrial organisations interested in the work of the Laboratory are invited to apply to the Director, National Physical Laboratory, Teddington, Middlesex, not later than Saturday, June 5th.

UNIVERSITIES AND THE STEEL INDUSTRY.—The United Steel Companies, Ltd., recently invited fourteen Professors of Mechanical Engineering from eleven different universities to visit its works in Sheffield and Scunthorpe. The visit, which lasted four days, was designed to help bridge the gap between industry and the universities by giving the university men an opportunity of seeing the special problems of the steel industry and the steel men the chance of discussing with the professors the latest ideas on engineering. Discussions were arranged on the dependence of metallurgical developments on engineering research, with particular reference to such problems as the handling of scrap and the flow of gases in open hearth furnaces. A discussion on industrial research was opened by Sir Charles Goodeve, F.R.S., Director of the British Iron and Steel Research Association.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Supervising Electrical Engineers

Tuesday, June 1st.—S. E. LONDON BRANCH: Castle Hotel, High Street, Eltham. Technical Film Show, "On-Load Tap-Changing Transformers." 8 p.m.

Chemical Society

To-day, May 28th.—Trinity College, Dublin. "Absorption Spectra as Chemical Tools," A. E. Gillam. 7.45 p.m. Washington Singer Laboratories, Prince of Wales Road, Exeter. "Advances in Immunochemistry," M. Stacey. 4.30 p.m.

Thursday, June 3rd.—Royal Institution, Albemarle Street, W.1. "The Modern Theory of Valency," L. C. Pauling. 7.30 p.m.

Incorporated Plant Engineers

Monday, May 31st.—Mines Department, The University, Leeds. "Steel," Mr. Ervine. 7.30 p.m.

Wednesday, June 2nd.—LONDON BRANCH: Royal Society of Arts, John Adam Street, Adelphi, W.C.2. "Plant in the Plastics Industry," Part II. F. W. Parker. 7 p.m.

Thursday, June 3rd.—PETERBOROUGH BRANCH: Gas Company's Film Theatre, Church Street, Peterborough. "Gas Manufacture," F. A. Reid. 7.30 p.m.

Friday, June 4th.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham. "Food Processing Plant and its Maintenance," L. D. North. 7.30 p.m.

Institution of Engineering Draughtsmen and Designers

To-day, May 28th.—Royal Society of Arts, John Adam Street, Adelphi, W.C.2. "Three-Dimensional Engineering Drawings," W. E. Walters. 7 p.m.

Institution of Locomotive Engineers

To-day, May 28th.—Dorchester Hotel, Park Lane, W.1. Reception and Luncheon. 12 noon.

Institution of Mechanical Engineers

Saturday, May 29th.—MIDLAND BRANCH GRADUATES' SECTION: Shakespeare Memorial Theatre, Stratford-on-Avon. Annual Summer Meeting and Ladies' Afternoon. 2.30 p.m.

Institution of Production Engineers

Thursday, June 3rd.—HALIFAX GRADUATE SECTION: Visit to Cammell Laird's, Birkenhead. 2 p.m.

Institution of Structural Engineers

To-day, May 28th.—MIDLAND COUNTIES BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham. "Some Impressions of a Tour Through Germany," J. D. Vaughan. 6 p.m.

Monday, May 31st.—MIDLAND COUNTIES BRANCH, GRADUATES' AND STUDENTS' SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham. "History of Structural Engineering," H. W. Coultas. 7 p.m.

Junior Institution of Engineers

Wednesday, June 2nd.—MIDLAND SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham. "A New Approach to Band Conveyors," O. J. B. Orwin. 6.30 p.m.

Royal Institution of Chartered Surveyors

Monday, May 31st.—12, Great George Street, S.W.1. Annual General Meeting. 5 p.m.

Catalogues

VAUGHAN CRANE COMPANY, Ltd., Openshaw, Manchester, 11. Catalogue of lifting and handling equipment.

SUNVIC CONTROLS, Ltd., 10, Essex Street, Strand, W.C.2. Pamphlet entitled "Electronic Relay, Type E.A.2."

MUSGRAVE AND CO., Ltd., St. Ann's Works, Belfast. Pamphlets dealing with propeller fans, and drying and dryers.

MATHEW BROTHERS, Matbro Works, Sandy Lane North, Wallington, Surrey. Folder on air compressor plants.

SMITHS INDUSTRIAL INSTRUMENTS, Ltd., Cricklewood, N.W.2. Illustrated booklet entitled "The Smiths of England."

AVELING-BARFORD, Ltd., Grantham. Illustrated pamphlet showing Aveling-Barford 4½ cubic yard dumper in action.

SAMUEL FOX AND CO., Ltd., Stocksbridge Works, near Sheffield. Catalogue No. SF 229, entitled "Steel Wire and Strip."

MACHINE SHOP EQUIPMENT, Ltd., 136–142, Victoria Street, S.W.1. Folder dealing with engineering instruments.

INTERNATIONAL COMBUSTION, Ltd., 19, Woburn Place, London, W.C.1. Illustrated brochure describing boiler plant.

C. A. PARSONS AND CO., Ltd., Heaton Works, Newcastle-on-Tyne, 6. Publication No. A.3, "High-Voltage Alternators."

B.S.A. TOOLS, Ltd., Birmingham. Catalogue covering the B.S.A. No. 48 single-spindle automatic screw machine (¼in capacity).

THE RAY ENGINEERING CO., Ltd., Waterdale Works, Southmead, Bristol. Leaflet giving details of standard plastic products.

Personal and Business

MR. F. A. BEAL has been appointed a director of Marshall, Sons and Co., Ltd.

MR. H. B. MCKINTY has been elected a director of Balfour, Beatty and Co., Ltd.

MR. DAVID R. LAMB, Editor of *Modern Transport*, has been elected President of the Institute of Transport.

MR. CHARLES GREENWOOD, M.I.C.E., City Engineer of Chester, has been elected President of the Institution of Municipal and County Engineers.

DUNLOP SPECIAL PRODUCTS, Ltd., has moved its headquarters to 19–20, New Bond Street, London, W.1 (telephone, Mayfair 9040; telegrams, "Dunspecial, London").

THE CHURCHILL MACHINE TOOL COMPANY, Ltd., announces the retirement of Mr. Herbert Asbridge, works manager. He has been in the company's service for nearly fifty years.

DR. H. ROXBEE COX has been elected President of the Royal Aeronautical Society. Sir John Buchanan, Mr. W. G. A. Perring and Mr. N. E. Rowe have been elected Vice-Presidents.

WILLIAM JESSOP AND SONS, Ltd., states that Mr. F. Wardrobe has retired from the post of chief engineer. He will continue to serve as a director of the company and as consultant on plant and engineering developments.

MR. W. J. PRICE has been appointed general sales manager of Birmingham Aluminium Casting (1903) Company, Ltd., in succession to Mr. E. W. Sanger, who has resigned to become joint managing director of Begwaco Meters, Ltd.

THE ASSOCIATED EQUIPMENT COMPANY, Ltd., announces that the amalgamation with the Maudslay Motor Company, Ltd., may now be regarded as an accomplished fact, as the holders of over 90 per cent of Maudslay ordinary shares have accepted the A.E.C. offer.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of report	Title	Post free s.	d.
B.I.O.S.			
1514	German General Rubber Goods Industry: Part III (Factory Lay-out and Plant)	38	2
1580	A Rapid Method for the Gravimetric Determination of Silicon with Particular Reference to Aluminium Alloys, as practised in Meterialprufungsanstalt, in Berlin	1	4
1622	The German Doll Industry ...	3	2
1628(Section4)	German Hand Tools Industry: Light Edge Tools	3	2
1628 (Section 6)	German Hand Tools Industry: Braces, Hand and Breast Drills, Metal Planes	1	7
1628 (Section 10)	German Hand Tools Industry: Soldering Irons (Electric) ...	3	2
1628 (Section 11)	German Hand Tools Industry: Organisation and Records ...	4	8
B.I.O.S.			
1650	Manufacture of Crotonaldehyde and Maleic Acid at I.G. Farbenindustrie A.G., Hoechst and Ludwigshafen	4	8
F.I.A.T.			
366	Production and Fabrication of Glued Wood Products in Western Germany	6	8
523/586 ...	Study of the Industrial Processing Instrument Industry in Germany	12	3
B.I.O.S.:			
JAP/PR/1426	The Iron and Steel Control Association	2	2
JAP/PR/1583	Japanese War Production Industries	2	2
1010	Oil Fields Investigation: The War Development of the German Crude Oil Industry, 1939–1945: Part I: North West German Crude Oil Industry: Exploration (Reichsbohrungen and Private) Wells	20	5
1011	Part II, Section 1.—German Oil Industry: Exploration ...	15	5
1012	Part II, Section 2.—German Oil Industry: Exploration Structures	30	8
1013	Part III, Section 1.—German Oil Industry: Development and Exploitation of Oil Fields	10	4
1014	Part III, Section 2.—German Oil Industry: Development and Exploitation of Oil Fields	40	8
1015	Part III, Section 3.—German Oil Industry: Oil Production Statistics and Analyses... ...	5	2
1016	Oil Fields Investigation: The War Development of the German Crude Oil Industry, 1939–1945: Part IV, Section 1.—The War Structure of the German Crude Oil Industry, 1934–1945...	20	8
1017	Part IV, Section 2.—The War Structure of the German Crude Oil Industry, 1934–1945: Private Industry ...	15	5
1188 (part 3)	Preliminary Survey of the German Pump Industry: Centrifugal, Axial Flow, Self-Priming and Reciprocating Pumps, &c.	9	3
1609	Compression Ignition applied to the Otto Cycle: The "Ring" Process	2	1
1628 (Section 2)	German Hand Tools Industry: Pliers, Pincers and Nippers ...	4	2
1628 (Section 5)	German Hand Tools Industry: Awl-Blades	1	7
1649	The German Surveying and Associated Industry	9	3
1651	Solvents and Plasticisers in Germany: Plasticisers Section ...	12	9
1652	Solvents and Plasticisers in Germany: Solvents Section... ...	6	8
1662	Methyl Chloride Production at I.G. Farben, Hoechst	1	7
1664	German Fibrous and Scientific Glass Industry	2	8
1667	Some Notes on German Open Hearth Furnace Design and Operation	3	2
F.I.A.T.			
915	The Manufacture of Sulfonamides and Related Intermediates in the French, British and American Zones of Occupation, Germany	17	10
1152	Design Practices and Construction of Centrifugal Compressors by Leading German Manufacturers	3	8
B.I.O.S.			
Misc. 45 ...	Description of a Graphical Method of Calculating a Transductor	6	2
Misc. 46 ...	Aircraft Batteries (Lead and Alkaline): The Accumulatoren Fabrik A.G. Hagen: Hannover Plants	6	2
Misc. 54 ...	Investigation of German Aircraft Protective Coatings... ...	1	7
JAP/PR/923	Japanese Fuels and Lubricants: Pine Root Oil Programme ...	17	11
JAP/PR/1308	Japanese Optics	3	8
JAP/PR/1323	Characteristics of Japanese Naval Vessels: Shipboard Electrical Equipment	38	2
703	German Methods of Excavating and Briquetting Brown Coal ...	20	4
1535	Report on Investigation of Methods of Gaseous Metal Treatment	2	1
1615	The German Metal Finishing Industry	20	5
1623	Manufacture of Sulphuric Acid: Report on the Examination of Certain German Vanadium Contact Catalysts	7	2
1626	German Chlorinated Rubber ...	5	2
1645	Manufacture of Sulphuric Acid: Die Gaswerke Frankfurt A.M....	1	1

Technical Information and Documents Unit, German Division, Board of Trade, 40, Cadogan Square, S.W.1, which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

Contracts

CHANCE BROTHERS, Ltd., has received a contract from the Crown Agents for the Colonies for the supply of three new lighthouses for Nigeria. The approximate total value of the contract is £16,500.

THE BRITISH ELECTRICITY AUTHORITY states that Since April 1st contracts have been placed for generating station, switching and transforming station and transmission equipment amounting in the aggregate to £1,501,782.

THE BRITISH ROPEWAY ENGINEERING COMPANY, Ltd., has received from the New Zealand State Coal Mines an order for a bicable aerial ropeway for use at the Westpost Stockton open cast mines in the South Island. Coal has to be carried at the rate of 250 tons per hour over a distance of 5½ miles to the screening plant, there being a fall of about 2600ft from the mine to the unloading point. Over 100 trestles, nine stations and seven protection bridges are required, and about 385 buckets, each carrying a load of 30 cwt, will be used on the ropeway. The value of the contract is stated to be about £280,000.

A Seven-Day Journal

Festival of Britain, 1951

In a Seven-Day Journal note on December 12, 1947, we recorded the Government's proposals for the "Festival of Britain, 1951." Those proposals included the planning of two major national exhibitions to be held in existing buildings. One of these exhibitions will be representative of Science and Technology, and early this week the Lord President of the Council announced the setting up of a Council to advise on the arrangements. Sir Alan Barlow has been appointed Chairman of the Council for the Exhibition of Science and Technology, the other members of which are Sir Wallace Akers, Sir Stanley Angwin, M.I.E.E., Sir Edward Appleton, F.R.S., Sir Alfred Egerton, F.R.S., Sir John Fryer, F.R.S., Sir William Halcrow, M.I.C.E., Sir Edward Mellanby, F.R.S., Professor Andrew Robertson, F.R.S., Sir Edward Salisbury, F.R.S., and Sir Frank Smith, F.R.S. Mr. Ion Cox is secretary to the Council. The Lord President has also announced the constitution of a Council to advise on the contribution to be made to the Festival of Britain by architecture, town planning and building research. This Council consists of Mr. H. V. Lobb, F.R.I.B.A., chairman; Professor H. V. A. Briscoe, D.Sc., Mr. F. J. Forty, M.I.C.E., Mr. Robert Matthew, F.R.I.B.A., Mr. Roland Nicholas, M.I.C.E., Sir George Pepler, Mr. J. M. Richards, A.R.I.B.A., and Mr. Howard Robertson, F.R.I.B.A. The general arrangements of the Festival as a whole are under the supervision of a Council of which Lord Ismay is chairman. H.R.H. Princess Elizabeth, as President of the Royal Society of Arts, took the chair at the first meeting of this Council in London on Monday last. The Lord President, as the Minister responsible for the Festival, said that the decision to hold it was an act of faith in the ability of this country to overcome its economic difficulties, and of faith that by 1951 those difficulties would be mastered and that we should be able to present to the world a smiling face of honest pride in a job well done.

Report on the L.N.E.R. Goswick Derailment

The report to the Minister of Transport by Colonel A. C. Trench and Lieut.-Colonel G. R. S. Wilson on the railway accident which occurred on October 26, 1947, at Goswick, between Berwick and Newcastle, on the L.N.E.R. main East Coast line, has now been published by the Stationery Office. It will be recalled that the 11.15 a.m. express passenger train from Edinburgh to King's Cross was derailed while traversing at high speed a facing connection leading from the up main to the up independent line, such diversion being necessitated by engineering works on the up line a short distance ahead. The roll of casualties was heavy, and twenty-seven passengers and one train attendant lost their lives. Serious injuries were sustained by fifty-nine passengers and six of the company's staff. It is clear, the report says, that the derailment was caused by the train passing through the junction on the up independent line at excessive speed. There was no defect in the permanent way or the locomotive, and there is no doubt that the distant signal was correctly displaying caution, and that the up main starter was at danger throughout the morning. The main responsibility for the accident, the report states, must rest on Driver Begbie, who failed to see the distant signal and made no attempt to see if it was visible from the other side of the footplate. Having failed to see the distant signal he did not exercise reasonable and proper caution by a substantial reduction of speed until he could be certain that all the Goswick signals were clear. Although there is no evidence to confirm it, the Inspectors cannot but feel, they say, that his grave breach of discipline in taking an unauthorised passenger on the footplate may well have had some bearing on his failure to exercise proper caution in the operation of his train. Contributory causes of a lesser degree were the failure of Driver Begbie, Fireman Baird and Guard Blaikie to see the notices of diversion before leaving Edinburgh. The final sentences of the report say that this deplorable accident again suggests that the installation of automatic train control should be accorded high priority, and it emphasises the need for a review, in order that design may be agreed, and a general programme prepared, for initiation as soon as circumstances permit.

Machine Tool Trades Association Luncheon

As a preliminary to the Machine Tool and Engineering Exhibition, which opens in London in August next, the Machine Tool Trades Association held a luncheon on Wednesday, May 26th. A particularly large number of members and guests were present, and in his welcoming address Mr. J. Holland Goddard, the President, pointed out that the forthcoming exhibition will be the largest display of British and imported machine tools that has ever been held in this country. It was realised by the Association that, despite its aim to obtain the largest possible volume of orders from all export markets, the engineering industry at home must keep its machine tools up to date in order to maintain production efficiency. He was not in favour of the high export target which had been set for the machine tool industry, as there were sound grounds for the view that there would be greater benefit to other industries' export targets if the supply of machine tools to buyers in the home market were more readily available. In replying to this welcome Sir Peter F. Bennett first recalled in a most entertaining manner his experiences in the acquisition and supply of machine tools, in his early days and during the war years. He went on to congratulate the industry on its growth and enterprise, and stressed the need for pooling the resources of the manufacturer and the machine tool builder to develop the most efficient machine for the job. Sir Peter strongly deprecated the high export target which had been set for the machine tool producers. In exporting these capital goods in such large numbers to the detriment of home industries. we were giving overseas producers the primary means of competing with our exports of consumer goods in the future. He pointed out that the principal means of reducing the cost of consumer goods for the export market was to produce them cheaply on the most efficient and up-to-date machines, and, instead of using these machines we were exporting them on a short-term export programme which could only have disastrous results in the future.

The Institution of Municipal Engineers

The seventy-fifth annual general meeting and conference of the Institution of Municipal Engineers opened at Scarborough on Tuesday last, June 1st, and will be concluded tomorrow, Saturday. The newly-elected president is Mr. Charles Greenwood, M.I.C.E., City Engineer and Surveyor of Chester, who delivered his address on Wednesday morning. In the course of it, he spoke of the important place of the municipal engineers in town planning and commented upon some of the plans that had already been produced. After a reference to the additional 750,000 acres of land which it was hoped to put under arable cultivation this year, and to the stepping-up of home food production, Mr. Greenwood pointed out that demands were also being put forward for the appropriation of large areas of land for roads, open spaces, schools, housing schemes, new towns, industry, defence, and many other purposes, apparently without any consideration or co-ordination of increased agricultural requirements. He wondered whether it was realised that a road 120ft wide absorbed nearly fifteen acres of land per mile and said that he could only guess at the total length of roads of that order which had been projected throughout the country but thought that 3000 miles was not an excess figure. Bearing in mind all the requirements for land which were mentioned in various plans, Mr. Greenwood expressed the view that the present demands seemed to be somewhat prodigal. The amount of land in this island was, he said, strictly limited and it would be an idle mockery if in order to provide healthier surroundings for our people we starved them of food. Finally, Mr. Greenwood urged that our present planning should proceed with greater caution, and that all schemes should be drawn up with the greatest flexibility, instead of trying to plan in detail for the next fifty to 100 years. The progress of events today, when new ideas and inventions crowded upon each other in rapid succession, made accurate prognostication an impossibility.

Air Commodore Whittle's Award

On Thursday, May 27th, it was announced by the Ministry of Supply that the Ministry and the Treasury had received and accepted a recommendation from the Secretary of the Royal Commission on Awards to Inventors that a total award of £100,000, free of tax, should be made to Air Commodore Frank Whittle, C.B., C.B.E., in respect of his achievements in the science of aeronautics, this award, of course, relates to his work in devising and developing practical means of applying the principle of jet propulsion and for his improvements in the designs of gas turbines and air compressors for use in connection with jet-propulsion. It will be recalled that Air Commodore Whittle had earlier refused to claim money from the Crown for his invention on the ground that he was a serving officer and that for the same reason when his firm of Power Jets, Ltd., was taken over by the Government when forming the National Gas Turbine Establishment, he refused an offer of £48,000. It was felt by the Government that he should have recognition for his inventions, which are now being extensively used not only for the Royal Air Force, the Government and British industry, but also by foreign governments.

Institute of Metals 1948 (Platinum) Medal Award

At a dinner held at the Savoy Hotel on Wednesday, May 26th, the President and Council of the Institute of Metals honoured Mr. Robert C. Stanley, the chairman and president of the International Nickel Company of Canada, and Dr. Paul D. Merica, the vice-president of the International Nickel Company. During the evening the President, Sir Arthur Smout, presented Mr. Stanley with the Institute of Metals (Platinum) Medal for 1948, in recognition of his outstanding services to the non-ferrous metal industries. They were all proud, he said, that among the former recipients of that medal was Dr. Paul Merica, Mr. Stanley's friend, colleague and fellow countryman. Mr. Stanley, he said, became associated with the original International Nickel Company in 1902, and he became its president in 1922. In these twenty years Mr. Stanley gained much experience of works management, much of it in a relatively junior position. The intimate knowledge of all branches of the nickel industry thus gained had, Sir Arthur Smout said, been of inestimable value to Mr. Stanley in framing the policy and controlling the destinies of that great organisation, which enjoyed a most enviable reputation for quality of products, honesty of business dealings, integrity of purpose, courage and enterprise. He recalled that last September Mr. Stanley had received from His Majesty the "King's Medal for Service in the Cause of Freedom" for his civilian service to the Allied cause. In presenting the medal to Mr. Robert Stanley, Sir Arthur Smout added the best wishes of all the members of the Institute.

Remarkable Freight Locomotives: Pennsylvania Railroad

By E. C. POULTNEY, M.Inst.Loco.E.

No. II—(*Continued from page 514, May 28th*)

THE tests of the "Q 2" class locomotive No. 6175, were very comprehensive, covering a total of forty-four different experiments carried out at speeds varying between the limits of 32 m.p.h. and 61 m.p.h., that is 160 to 300 r.p.m. The nominal cut-offs used varied from a minimum of 20 per cent to a maximum of 47 per cent. Two series of tests were made. The first series were divided into two separate groups, the first comprising seventeen tests when the exhaust from the feed heater hot water pump was discharged into a condenser, and a further five tests with this exhaust steam returned to the feed heater. For these tests the smokebox draughting equipment was as designed. Following these a further twenty-two tests were made when the hot water pump exhaust was turned into the heater, which is the normal method of working, and the smokebox draughting arrangement modified by omitting the deflector plate projecting downwards at the front of the table plate, which had the effect of increasing the gas passage area at this point from 9·0 square feet to 13·6 square feet. These tests were also divided into two different series, half being made without induction tubes in the sides of the firebox and half with the induction tubes. These induction tubes, of which thirty-five were fitted in each side of the firebox, have an outside diameter of 2in, and add to the air supply above the fuel bed.

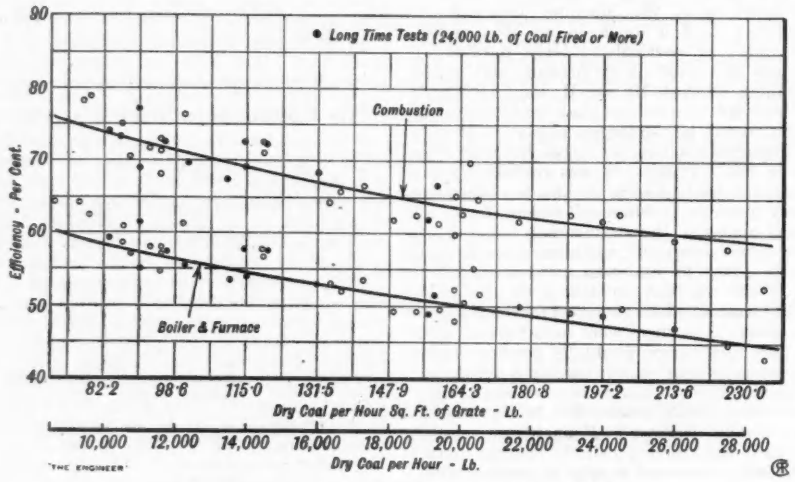


FIG. 6—BOILER AND COMBUSTION EFFICIENCIES

A selection of eleven out of a total of twenty-two tests made after the deflector plate had been removed and with the hot water pump exhaust returned to the feed heater, both with and without the induction tubes, are indicated in Table IV, and are those which will form the basis of this article. Table VII, "Steam Supply to Engines," will give the engine running conditions for all the tests now under notice.

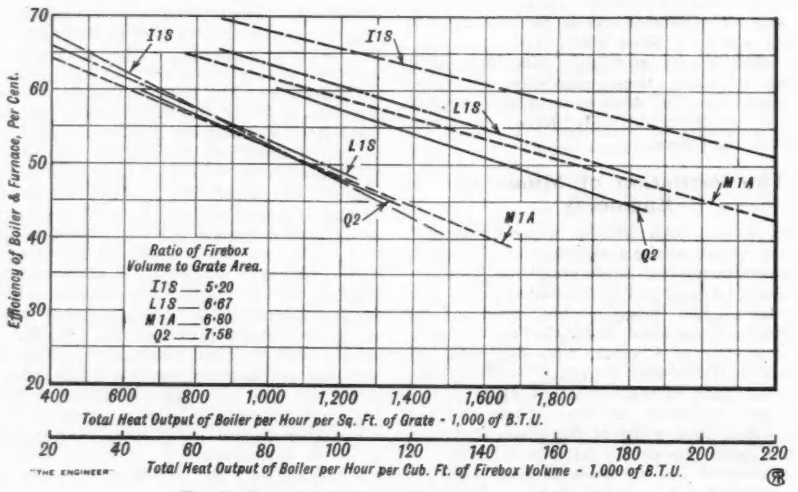


FIG. 7—COMPARATIVE EFFICIENCIES OF BOILERS

Coal Used for the Tests

The following are representative analyses of the coal used, comprising samples from two different cars:—

Proximate Analysis

	No. 1	No. 2
Fixed carbon	61·07	51·39
Volatile matter	28·73	32·35
Moisture	0·46	0·33
Ash	9·47	12·93
Sulphur	1·17	1·73

Ultimate Analysis

Carbon	78·16	73·27
Hydrogen	4·86	4·86
Nitrogen	1·52	1·57
Oxygen	4·53	5·35
Ash	9·78	12·97
Sulphur	1·18	1·98
Calorific value. B.Th.U. per lb dry	14,037	13,252

Firebox Air Supply

Particulars of the air supply to the firebox are as under:—

Grate area	121·7 square feet
Air inlet through grate	20·76 square feet
Ratio of air inlet through grate to total area	0·17
Air inlets above fuel bed without induction tubes	0·04 square feet
Air inlets above fuel bed with induction tubes	1·19 square feet
Ratio of total air inlets to grate area with induction tubes	0·18
Air inlets to ash pan	10·6 square feet

For the purpose of examining the performance of this locomotive seven tabulated statements have been drawn up, each one of which deals with a specific phase in the action of the locomotive in converting the heat energy in the fuel fired into work on the drawbar as shown by the test plant dynamometer.

Tables IV, V, VI and VII appertain to the boiler performance. Tables VIII and IX refer to the performance of the engines and the remaining table, X, gives information as to the power developed at the drawbar and the heat units required per unit of power developed. In other words, this table gives the performance of the locomotive as a whole.

During all the twenty-two tests made under the conditions above mentioned, the boiler evaporated from 71,909 lb to 137,479 lb of water per hour and the quantity of coal fired varied between the limits of 11,355 lb and 30,000 lb per hour, corresponding to firing rates, based on the coal "as fired," of 93·3 lb and 216·5 lb per square foot of grate area per hour. These are very impressive results but not more so than the powers developed, which it will be observed ranged from 4736 to a maximum of no less than 7987 i.h.p., corresponding to 4016 d.b.h.p. and 6782 d.b.h.p., respectively. The cylinder horsepower developed per square foot of grate area ranged from 38·9 i.h.p. to 65·6 i.h.p.

Boiler Efficiency and Heat Distribution

The efficiency of the boiler and superheater based on the firing rate coal "as fired" lb per square foot of grate area per hour ranges between 61·4 and 42·6 per cent. This is the actual efficiency calculated from the temperature of the feed water as delivered by the feed heater. For most of the tests the feed heater supplied all the feed required. For tests Nos. 1729 and 1749, however, the water supplied by the heater was supplemented by occasional use of the injector, and in the case of tests 1748, 1746, 1747, and 1745, the injector was used continuously.

Table IV shows in addition to the boiler efficiency the heat losses due to external radiation, losses due to coal escaping unburned, and the heat loss in the smokebox gases.

The boiler and combustion efficiencies are shown by Fig. 6 plotted against the rate of firing dry coal lb per square foot of grate area per hour. The provision of

the combustion tubes admitting a secondary air supply above the fuel bed does not appear to have materially affected the combustion efficiency.

Table V shows that the air supplied through these tubes varied from about 23,000 to just over 30,000 lb per hour.

The combustion efficiency is almost entirely determined by the losses in unburned coal, which at very high rates of firing may reach as much as 44 per cent of that fired. The loss through the formation of CO, which is very small, represents heat losses that do not exceed 2·4 and are usually less than 1 per cent. The heat losses in the smokebox gases are consistently low. This is due to the comparatively low gas temperatures, ranging from 567 to a maximum of 664 deg. Fah. The reduction in the gas produced per lb of coal burned affects the quantity of heat in the smokebox gases as the rate of working advances. This is common to all boilers and the comparatively small heat losses shown by these tests is largely due to the good absorption efficiency of the "Q 2" boiler.

When remarking on the performance of this boiler, and particularly on its efficiency, the following comments were made regarding the influence of firebox proportions:—

"There is no dispute about the fact that increasing the size of the firebox increases the boiler efficiency, but there is a difference of opinion as to whether this is due primarily to the increase in grate area or to the increase in firebox volume. In 1907 tests of class 'E 2a' locomotives on the locomotive test plant showed that 53 per cent of the grate could be bricked over without decreasing the boiler efficiency when using gas coal. This coal, consisting largely of lumps, was handfired and only at comparatively low rates. Under these conditions, the spark loss is low and it is not surprising that the grate area had little effect on the efficiency of combustion."

The statement is also made that stoker firing with a friable coal would result in a higher spark loss, particularly at high combustion rates.

"Under such conditions it would seem important to have a large grate area to reduce the velocity of the air through and above the fire and thus lessen its ability to entrain small particles of unburned or partially burned coal."

Further information on this subject is given by the graphs, Fig. 7. They compare the efficiencies of four boilers, locomotive classes "I 1s," "L 1s," "M 1a," and "Q 2," on the basis of equal heat outputs per square foot of grate area, and below them the comparison is made on the basis of the heat output per cubic foot of firebox volume.

In commenting on these plots, the following are observations:—

"It would appear that the large firebox volume of the 'Q 2' boiler has not produced a corresponding increase in boiler efficiency and that the good efficiency of this boiler can be attributed to the large grate rather than to the large firebox volume. An increase in grate area necessarily results in a corresponding increase in firebox volume, but an additional increase in firebox volume, obtained by using a larger combustion chamber, does not appear to be very helpful from the standpoint of combustion efficiency."

TABLE IV.—*Boiler Performance; Efficiency and Heat Distribution*

Test No.	Coal (lb) as fired per square foot of grate area, per hr-lb	Boiler efficiency, per cent	Heat loss per cent due to: External radiation	Unburned coal	Carbon monoxide	Heat in smokebox gases	Coal burned per cent coal-fired	Efficiency (per cent): Combustion	Absorption
Without Induction Tubes									
1730	94·6	54·8	2·74	30·94	0·0	11·52	69·06	69·06	83·3
1751	93·3	61·4	3·07	22·68	0·31	12·54	77·32	77·01	83·7
1731	113·8	53·6	2·68	32·17	0·28	11·27	67·83	67·55	83·3
1750	118·3	57·9	2·90	26·39	0·59	12·22	73·61	73·02	83·3
1729	197·2	49·3	2·47	36·68	0·72	10·83	63·32	62·60	82·7
1735	166·4	49·2	2·46	36·32	1·44	10·58	63·68	62·24	83·0
With Induction Tubes									
1740	86·4	59·1	2·96	25·5	0·31	12·10	74·47	74·16	83·7
1755	100·3	57·4	2·84	27·34	0·31	12·08	72·66	72·35	83·3
1739	118·5	54·1	2·71	30·29	0·61	12·28	69·71	69·10	82·2
1760	125·0	57·5	2·88	27·29	0·0	12·33	72·71	72·71	83·0
1741	163·9	51·9	2·60	33·04	0·29	12·17	66·96	66·67	81·7

TABLE V.—*Boiler Performance; With and Without Induction Tubes*

Test No.	Air through induction tubes per hr-lb	Draught centre of firebox (inches, water)	Excess air, per cent	Coal "as fired" (lb): Total	Per hour	Equivalent evaporation: Per hour per lb dry, coal-fired, lb	Per hr-lb	Average boiler pressure, lb per sq in	Boiler efficiency, per cent
200—25—F									
1740	23,109	1·5	32·8	24,544	10,519	8·5	86,805	293	59·1
1755	26,446	1·8	32·8	24,410	12,205	7·7	90,859	296	57·4
1730	—	1·9	32·3	24,935	11,508	8·0	87,729	295	54·8
1751	—	2·1	25·1	22,351	11,355	8·4	92,275	293	51·4
240—30—F									
1739	26,153	1·9	37·6	24,042	14,425	7·8	108,878	293	54·1
1760	28,744	2·3	26·9	25,364	15,218	7·7	111,725	296	57·5
1731	—	2·5	29·6	25,398	13,853	7·9	106,006	294	53·6
1750	—	2·8	21·8	24,000	14,400	7·9	110,089	294	57·9
280—35—F									
1729	—	2·6	—	8,000	24,000	7·1	162,816	294	49·3
1741	30,480	2·6	30·2	26,590	19,943	7·1	136,312	293	51·9
1735	—	3·3	16·1	27,000	20,250	7·1	135,470	294	49·2

Note—Test No. 1729: Test conditions 280—40—F maximum i.h.p. test.

The Feed-Heater Equipment

The "Q 2" class engines are fitted with feed-water heaters of the Worthington type, supplied by the Worthington Pump and Machinery Corporation. This equipment is made up of three separate units comprising a rotary turbine-driven variable-speed cold water pump drawing water from the tender and delivering to a mixing chamber placed in the smokebox immediately in front of the chimney. The cold feed is delivered into the heater through a spray chamber, where it mixes with exhaust steam taken from the exhaust passages from the main cylinders. The hot water from the heater is then delivered to the boiler by a single horizontal long stroke close-coupled piston type pump.

The mixing chamber is fitted with a float operating a balanced steam valve regulating the supply of steam to the cold water pump turbine, and an air vent is also provided to allow of the escape of the air released from the water due to the heating action in the heater.

The rate of feed to the boiler is entirely controlled by the speed of the hot water pump, thus only one control valve is required. The height of water in the mixing chamber is governed by the float actuating the valve controlling the steam supply to the cold water pump turbine. The cold water supply is thus automatically controlled according to the boiler demand for feed. The cold water pump is placed below the footplate and the hot water pump is mounted in a transverse position at the front of the engine below the smokebox, thus allowing of the hot water flowing into the pump.

When the boiler feed supply is entirely obtained from the heater, the heat saving is found to vary from about 10 to 11·7 per cent. The average saving is approximately 10·5 per cent and is independent of the rate of heat output by the boiler. Taking as specific cases tests 1731 and 1728, the total heat output by the boiler is 102,868,000 B.Th.U. and 145,639,000 B.Th.U. per hour, and the heat saving by the heater is 12,166,000 B.Th.U. and 19,378,000 B.Th.U., representing heat savings equal to 10·6 and 11·7 per cent of the boiler output. Thus, the feed water heater adds at least 10 per cent to the boiler capacity.

To further illustrate the working of the feed heater, the following are particulars appertaining to test 1731:—

	Deg. Fah.
Temperature of cold feed water	50
Temperature of exhaust steam entering the heater	324
Temperature of cold feed entering heater ...	101
Temperature of hot feed entering the boiler ...	218

The rise in the temperature of the cold feed between the cold water pump and the heater is due to the pipe conveying the feed passing through a jacket, through which flows the steam and water escaping from the air vent in the body of the heater. This adds from 40 deg. to 50 deg. to the cold feed temperature.

(To be continued)

TECHNICAL EDUCATION IN MANCHESTER.—The Regional Advisory Council for Technical and other forms of Further Education for Manchester and District has now issued its annual report for 1946–47. It notes, amongst many other items, that the Engineering Sub-Committee has maintained the machinery for consultation with engineering employers, trades unions and the professional institutions which resulted in the craft apprenticeship scheme being published some time ago. The problems of a training scheme for semi-skilled workers are now being investigated.

Coal Mining in the United States of America

By SIR R. A. S. REDMAYNE, K.C.B.

UNDER this heading I intend to subject to a critical examination Mr. T. E. B. Young's recently issued "Report on Visit to the Coal Fields of the United States of America, together with his comments on Various Aspects of Coal Production in British Mines." His visit was made at the instigation of the National Coal Board, which, on July 15, 1947, invited him to carry it out with the object of surveying the latest and projected types of American equipment and methods of mining of deep mined and opencast coal. In the pursuance of his objective he arrived in America on September 24, 1947. Although he does not state the period of time devoted to his inspection, the ground covered by him was fairly comprehensive, for he visited the coalfields of Pennsylvania, West Virginia, Illinois, and Colorado, and he believes that the mines he saw were "representative of the individual coal-mining districts." But he feels he must confine his description to his own observations. The results of his observations are embodied in a comprehensive yet succinctly compounded report, which should prove to be both enlightening and helpful to those British mining experts who have not had the advantages of studying American mining practice *in situ*, especially as very fortunately the author of the report found "it was inevitable (as it was desirable) that I should reflect on the position which I had left behind in Britain, and that I might place a rather wider interpretation on the words of the Board Minute than is actually contained in specific terms in so far as this report is concerned." Mr. Young's professional record is such that we may place complete reliance on the validity of the conclusions at which he has arrived. Not only was he over a considerable period the general manager of the large and successful Bolsover group of collieries, but he was loaned to the late Government to act in a technical advisory capacity to the Ministry of Fuel and Power, under, I believe, the title of Director of Coal Production, and he is now, at the moment of writing, the sole mining expert on the National Coal Board. It will be realised therefore that his knowledge of his subject is both catholic and intimate.

Statistical Results

Relative Outputs per Manshift.—The comparative statistical results, in point of output of coal per person employed, as between Great Britain and U.S.A., is so much more favourable to the latter country that it has impressed not only British mining men but economists, and the thinking public also. Mr. Young himself in the preface to his report directs attention to it, intimating that his report "should be read against the background of the Statistical Comparison," which he gives. Incidentally, as to the output per manshift of the productive coalface workers, the comparative figures for the year 1947 are: U.S.A. bituminous mines, 6·4 tons; Great Britain, 2·80 tons; or if we take into account all workers, surface and underground, 4·6 tons and 1·07 tons respectively. But Mr. Young does not mention the fact that the time worked at the face in the coal mines of U.S.A. is longer than in British mines. Except in the case of those British mines in which the extra half hour is worked per shift instead of working on the Saturday, the time worked per day in the U.S.A. is seven hours and in Great Britain six hours and a quarter. So for the purpose of strict comparison the figures should be reduced to a common basis.

The present writer, in his little book, "The Problem of the Coal Mines" (January, 1945), stated (introduction): "Comparisons regarding relative productivity are instituted between British, Continental and American collieries, mostly to the detriment of the first-named, by critics of the conduct of the British industry, entirely oblivious of the fact that the natural conditions obtaining in the respective countries are very different." And, again (page 29), "Not only are the geological conditions in the coal mines of the United States taken as a whole vastly more favourable to the application of mechanical coal-cutting than are those of Great Britain, they are also, normally, flat (except in the anthracite region) with very good roofs, and of suitable average thickness; moreover, they are less cut up by faults, relatively free from inflammable gas and spontaneous combustion, and usually dry. Where water does exist the pumping is from shallow depths." It is gratifying, therefore, to find emphatic confirmation of this view by Mr. Young, who states "It must be recognised—and I cannot too strongly emphasise the point—that the natural and geological conditions in this country are so completely different from those existing in the coal-producing districts in the States that an approach to parity with American productivity as measured by output per manshift worked is unobtainable," and he sets out the nature of the superior natural conditions existent in the U.S.A. similar to those given by the present writer.

Distribution of Labour.—Coming to labour distribution statistics, which he deals with under the heading of "General Practice," Mr. Young extracted figures from individual American companies' statistics, which, if those companies can be taken as representative of the whole industry, enable a comparison to be made with Great Britain in regard to the percentage of labour which is respectively devoted to productive work, i.e., to the actual production of coal and to non-productive work. Such figures are not easy to obtain nationally, as Mr. Young intimates. The figures he gives are so important that I reproduce them. They are as follows:—

	Typical American Mine Per cent	Great Britain Per cent
Actual productive labour	72	26·0
Ancillary work at face...	—	15·0
Underground haulage ...	8	15·0
Others underground ...	10	19·6
Surface	10	23·5

Everyone who has devoted close study to the subject must have come to the same conclusion as Mr. Young, that "it is a physical impossibility to raise the proportion of productive labour in British mines to the American level." For, as he says (page 14), "there is a widespread belief amongst all informed people that the solution of our production problem is the wholesale installation of American coalface machinery. Nothing could be further from the truth, for American machinery was designed to operate under American conditions and these are as different from ours as chalk is from cheese."

Reduction in Non-Productive Labour

Having set out the statistical position, let us see what, if any, improvements are possible in respect of our mines. In Mr. Young's opinion the only hope lies in the narrowing of the gap between productive and non-productive labour by an extensive revision of our transportation system (that is, haulage underground and surface) and the elimination of much surface labour. But to effect this revision must, in the nature of things (especially in the case of existing collieries), be a matter of some time.

Reduction in Underground Transportation Labour.—In the United States the underground haulage is largely operated by the electric trolley system. The flat seams, the freedom from faults, and the comparative exemption from inflammable gas in most of the mines permit the use of this system.

As to its economic applicability to British coal mines, might I suggest for consideration two points which seem to me to be of importance, namely, that the greater production at the coalface in the American mines as compared with British mines diminishes if it does not efface the more or less inactive periods in the feeding of the coal from face to haulage system, and, secondly, that the danger from ignition of firedamp or coal-dust from electric sparking is greater in British mines than in American.

Mr. Young is convinced "that in suitable conditions (particularly as regards gradients) the trolley locomotive is, with reasonable precautions as regards installation and maintenance, by far the most economic method of underground transportation. Where gradients are unsuitable for the locomotives he suggests that conveyors—even before subsidence has ceased—might be adopted. In one colliery, with which the present writer was concerned, the whole of the underground transportation from coalface to shaft was by conveyors, at another it was found to be uneconomic to replace the endless rope haulage by conveyors. Mr. Young's treatment of the subject of transportation constitutes, so it appears to the present writer, perhaps the most important part of his report, especially from the point of view of the opening out of new mines, where the haulage roads can be laid out to meet the requirements of large outputs.

Reduction of Surface Transportation of the Coal.—Mr. Young rightly comes to the conclusion that "there is much unnecessary manipulation of tubs between the pit and the tippler . . . and great economy can be effected by conveying the coal from a discharge point at or near the pit top to the screens," and much unproductive labour could be saved. "With few exceptions, the surface arrangements at British collieries have been designed with insufficient regard" to the saving of labour between the top of the shaft and the railway wagon. "Tipping cages carrying large mine cars, the latter discharging direct to a conveyor taking the coal to the screens," is Mr. Young's solution.

Coalface Mechanisation

I conclude, from a careful perusal of the report, that not much if anything is to be hoped for in the direction of face mechanisation except in regard to the mechanised loading of coal. As to that Mr. Young is emphatic; in all cases of mechanically cut coal loading should be mechanised also.

As Mr. Young remarks, "The absentee has

an even more serious effect on output in a mechanised mine than where handloading is in force and where the working of coal-loading is less skilled and a larger number of men are employed." But the same is true also in respect of the whole cycle of operations at the coal face—cutting, breaking down, and filling. As Sir Charles Reid has recently shown, were absenteeism reduced to a pre-war figure under the conditions of mechanisation at present existing, some 30,000,000 tons more would be forthcoming.

Methods of Working

Surely in his consideration of the subject of methods of working, Mr. Young is in error in stating that, in general, it is only possible to work one coal production shift in twenty-four hours on each working day, in the case of highly mechanised collieries and that the remaining two shifts are occupied in performing work ancillary to that of actual coal production? For the present writer has been connected with the direction of collieries in which two out of the three shifts were devoted to coal production: one shift in the mechanical under-cutting the coal faces and the succeeding shift in the breaking down and filling of the coal; the third shift to the making of height and packing the stone. Perhaps, however, we really are at one on this point. But if so the statement in the report requires some clarification.

The modification of the bord and pillar system practised in the coal mines of the United States, whilst suited to the conditions prevalent there, is unadapted, except in a comparatively few cases, to the economic working of the thin and deeper-seated seams of this country; consequently, as has already been stated, the labour-saving appliances employed in the former are also largely inapplicable to British coal mines.

Where the conditions are such as to permit of the working of the bord and pillar system, all three shifts can if necessary be employed in the production of coal, hence one reason for the higher percentage of productive labour in American coal mines as compared with the British.

Surface Preparation of the Coal

Mr. Young's remarks in regard to the means adopted in the States towards the elimination of the "unnecessary and wasteful use of labour" in the treatment of coal for the market, might with advantage have been expanded so as to allow of a better comprehension of these means. For instance, what is the nature of the "mechanical devices of various kinds," which are provided "for the separation of coal and dirt"; and what, precisely, is the character of the equipment by which "as many as thirty or forty 'pickers' can be replaced by two or three skilled operators"? Detailed information on these points would be valuable.

He points out that American practice, which at one time favoured the use of the "froth flotation" process in the treatment of fine coal, is now turning in the direction of the concentrator table. The overall capital and operating costs are much lower, and the results entirely satisfactory in respect of the latter.

He quotes in full the opinion of Mr. J. B. Morrow, the most experienced authority of coal preparation "in the States," in answer to his—Mr. Young's question, as to how he would propose designing a coal preparation plant for treating "run of mine" coal down to zero. Abbreviating his answer, it amounts to this:—

That he could see no justification for the production of very large coal; that he would break the over 6in down to 6in; the 6in to 2in to be cleaned in a gravity box; that the 2in to $\frac{3}{16}$in would be treated in a jig washer box, and the undersize therefrom passed through a Rheolavour trough; that the middlings from the last three traps of the Rheolavour washer would be discharged to a series of concentrator tables for final separation; and that the middlings from the gravity box and the jig box would be crushed and recycled with the minus $\frac{3}{16}$in.

Mr. Young suggests that a pilot plant might be set up on these lines for experimental purposes.

Conclusion

In this review of Mr. Young's excellent report, his sequence of treatment has not been followed and I have touched on only those matters which seemed to me to be of outstanding importance from the point of view of the future of the British coalmining industry. For instance, I have made no reference to opencast or strip-mining operations in the U.S.A. and Great Britain, to the consideration of which chapter V of the report is devoted. For, in regard to Great Britain (quite apart from the awful mess to land consequent from the quarrying of such coal), the supply of coal which can be so obtained appears to me to be so inconsiderable, both as to duration and possible annual output, as compared with the coal available by mining, as not to warrant the attention given to it by many persons. Rather should we concentrate on the enhancement of output from our mines proper.

Nor have I dealt with the electrical generating practice and its bearing on preparation problems and the nature of the coal to be used at power stations, which are controversial subjects and ones as to which one would like to have the views of consumers before pronouncing thereon. Everyone must agree, however, with Mr. Young that "it would be uneconomic to transport coal, containing a large proportion of high ash material over a long distance." This would be avoided were power generating stations situated near the source of coal production.

From a careful study of the report one arrives at the conclusion that there is little hope of any substantial increase in our annual output of coal in the near future from enhanced mechanisation or other technical means. Indeed, the author states frankly that in this respect his mission was a failure. The solution of the problem lies in the reduction of the voluntary abstention from work on the part of the miners, the provision of greater incentives to work, and, "at all levels, the organisation of the National Coal Board will have to be so arranged that mining engineers are given executive authority to carry out the functions delegated to them. In assuming this authority they will be expected to accept full responsibility and there must be no division either of responsibility or of authority in respect of the delegated functions."

Those are wise words, and closely analogous to those recently expressed by Sir Charles Reid—as indeed in some other respects also these eminent mining experts are apparently in close accord. Let us hope that the National Coal Board as a whole will read, mark, learn and inwardly digest them. It will be in the best interests of the Nation if they do so and carry them into practical effect.

The Société des Ingénieurs Civils de France

During this week, the Société des Ingénieurs Civils de France has been celebrating, in Paris, the centenary of its foundation. The celebrations, which began on Saturday last, May 29th, and ended yesterday, June 3rd, included a number of social functions, technical meetings and works visits, and were attended not only by a large company of members, but also by the President of the French Republic, Monsieur Vincent Auriol, and other distinguished guests. Among those who were present at the celebrations from this country were Sir Roger Hetherington, President of the Institution of Civil Engineers; and a contingent from the British Section of the Société, which included the President, Mr. M. G. J. McHaffie, and the Honorary Secretary, Mr. W. R. Howard.

The Société des Civils de France actually came into being in March, 1848, through the efforts of graduates of l'Ecole Centrale des Arts and Manufactures, Paris. It is, of course, the premier engineering society of France, its objects being akin to those of the leading institutions of Great Britain. Engineers in every branch of the profession and of any nationality are eligible for election either as corporate members or as associate members. The work of the Société is divided into eight sections, covering public works and civil engineering; industrial engineering and transport; mechanical engineering; mining and metallurgy; physics and chemical engineering; electrical engineering; agricultural engineering and food production; and industrial economy and organisation. The spacious and well-equipped building in Rue Blanche, Paris, which was opened in 1897 by the then President of the French Republic, is the Société's home.

The Société has several foreign branches, and the work of the British Section, which was established in 1919, is well known to our readers. The present membership of the British Section is round about 200, and its object is to establish closer professional and social relations between members resident in the United Kingdom and those in France and other countries.

At the official opening ceremony of the celebrations in Paris on Saturday last, Sir Roger Hetherington, President of the Institution of Civil Engineers, conveyed on behalf of all the foreign engineering societies represented cordial congratulations on the attainment of the Société's centenary. Sir Roger said that he welcomed the opportunity to express in the name of engineers all over the world admiration of the genius of French engineers of all time for what they had accomplished. During the past hundred years, an epoch which coincided with the history of the Société, French engineers had continuously upheld the traditions of preceding centuries, had conceived great projects and had proved their capacity to put them into practice. Turning to more recent times, Sir Roger referred to the lead which had been taken in France in the development of hydro-electric power stations, the design of bridges, the improvement of waterways, harbours and docks, and to the great advances in the use of reinforced concrete.

Moreover, Sir Roger continued, the world was particularly indebted to French engineers, and to such men as Coulomb, Bazin, Navier, Darcy, de Chezy and a host of others for the work they had performed in the realms of investigation and research which had led to many important developments in the theory and practice of engineering science. Finally, Sir Roger emphasised that ceremonies, such as these particular celebrations, between the great engineering societies of different countries assisted in the development of cultural relations between those countries and drew them together.

The Brush Electrical Engineering Company, Ltd., and its associated companies, Mirrlees, Bickerton and Day, Ltd., and J. and H. McLaren, Ltd., announce that they have signed contracts to the value of £2,000,000 and are expecting to sign further contracts valued at over £1,000,000 for the supply to Russia of diesel engines, diesel-electric generating sets and ancillary equipment.

Reconstructed M.S. "Venus"

WHEN the Elsinore built 7000-ton displacement m.s. "Venus" was first put into commission early in 1931 by her owners, the Bergen Steamship Company, Bergen, Norway, she was generally looked on as one of the most interesting motorships of her year. She had a speed of 20 knots and ran the Newcastle–Bergen service twice a week. She was well known and well liked by the many passengers she carried during the nine years before the war. In 1938 she and her sister ship, the "Vega," took 22,700 passengers between them in the summer months.

Soon after the outbreak of war the "Venus" was trapped in Norway by the German invasion of 1940. She was requisitioned by the invading forces in 1941, manned by a German crew and used as a U-boat tender operating mainly in the Baltic. After the German surrender in 1945 she was found sunk in shallow water in the heavily blitzed harbour of Hamburg. A bomb which fell in No. 2 hatch just forward of the navigating bridge had badly damaged the forward part of the hull, and a near miss had torn a hole—20ft by 15ft—in the skin, damaging the auxiliary engine-room, together with its equipment. The ship was salved later in 1945 by the British Navy, and after being made seaworthy was towed to the yard of her original builders at Elsinore in Denmark.

There was no accommodation there for taking a ship of "Venus'" length into dry dock. Fortunately, however, the Germans had left behind on their retreat from Denmark three well-equipped modern floating or "swim" docks. The largest of these was allocated to the Elsinore Shipbuilding Company, and sent to its repair shops at the nearby and commodious port of Aarhus. Even this dock was of insufficient length, and was not available for the job till the Elsinore Company had built an extra length of pontoon to tack on to the existing "swim" dock. Needless to say, "Venus" was in a very dirty condition throughout after her German occupation and long immersion, but inspection showed that her steelwork had been exceptionally well preserved during her fifteen years' life.

Faced with the problem of repair and reconstruction, the Bergen Line decided to tackle it thoroughly and incorporate a complete modernisation while carrying out the essential repairs. This modernisation has been influenced by the running experience of "Venus'" first nine years of service, and includes a new form of bow; alterations to the ship's stern and appearance generally; changes, improvements and additions to the passengers' and crew's accommodation; and some rearrangement of the propelling machinery and the auxiliaries.

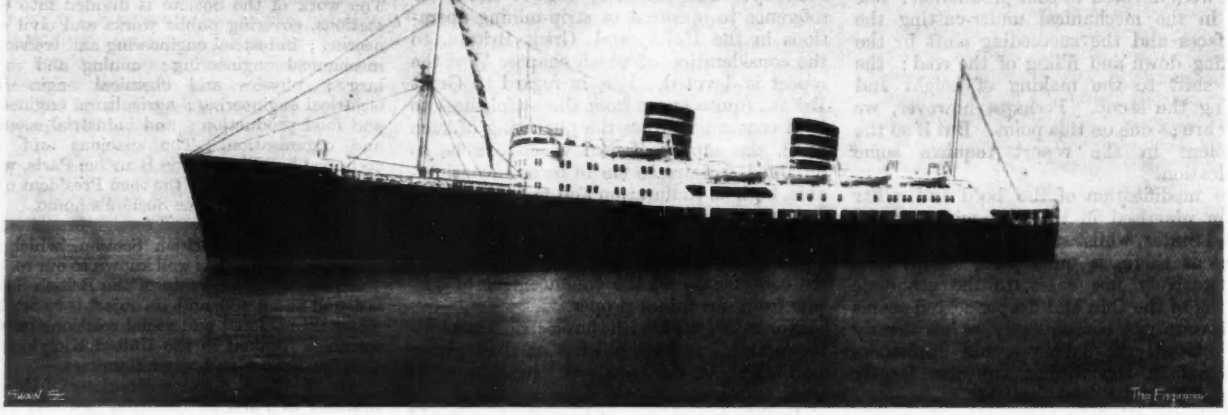
As a new fore end was necessary it was decided to abolish the steep sheer and fit instead a soft-nose stem, of a pattern in general use in modern Scandinavian ships. It is anticipated that this new form, adding some 20ft to her overall length, which now stands at 422ft with a beam of 54ft, will improve "Venus'" sea-going qualities, keep her fore deck drier when heavy North Sea weather is met and will help time-keeping under unfavourable conditions. At the same time, a longer forecastle has replaced the former one. Still dealing with the ship's "new look," the promenade deck has been extended aft, providing second class passengers with excellent open-air exercise space and new and additional passenger accommodation has been built in the space previously occupied by the after cargo hold. Cabins for the captain and navigating officers are on the bridge deck, and for the engineers on the boat deck above the engine casing, all very handy for duty. Crew's and stewards' cabins, mostly two-berth, are on the A and B decks forward and on B deck round the engine casing.

The "Venus" as originally commissioned had accommodation for 279 passengers in all, 203 first class (85 single berth and 59 double berth) and 76 second class. Now she will carry 400 in cabins and another 60 in group accommodation of the dormitory type, suitable for parties of Youth Organisations, in the upper between deck of No. 1 hold. The 144 first class passengers will be mainly in single cabins. On the promenade deck there are two suites de luxe and four special two-berth cabins, each provided with shower and toilet. In addition, some of the single cabins on B deck also have shower and toilet. A lift serves all first class decks. The 256 second class passengers are accommodated aft mainly in two and some four-berth cabins. All cabins are supplied with conditioned air, for which an extensive system of automatic controls has been installed.

The two forward cargo hatches have been retained and provide 60,000 cubic feet of refrigerated space. There is accommodation for thirty motor cars under cover. On the promenade deck there is an observation lounge fitted with large windows giving spacious vistas so characteristic of Scandinavian passenger ships; the first class hall and smoking room, and a large bar and lounge for the second class passengers, are on A deck aft. Both first and second class dining rooms, which have a joint galley and separate pantries, are situated on A deck. The galley is well equipped with modern labour-saving devices.

Originally the first class dining room had two rows of pillars and large portholes opening to the port and starboard alleyways. It was decided to reduce the pillars, close in the sides and resort to artificial lighting at all times. To enable this change to be made the accommodation for the ship's officers' two decks above has been built up into girder form supported by the ship's framing, and it is this girder which spans the dining saloon and the 54ft wide pillarless observation lounge. This modern practice has its counterpart in the big whale factory ships where the whale flensing and cutting-up floors are freed as much as possible of heavy supporting stancheons by girder-built crew's cabin accommodation underneath them.

When first built "Venus" was an all-riveted ship. The rearranged bow end is also riveted, but for the new accommodation welding has been used freely. It would, indeed, have been difficult to have done so much and so well without welding. There are great hopes that this welded technique will be of lasting benefit in that it cannot "work" with age under stress of North Sea conditions, and various creakings traceable to slight movements in riveted joints will be eliminated entirely.



RECONSTRUCTED MOTOR SHIP "VENUS"

The architect for the interior decorations is Professor Palle Sverson, of Copenhagen. Mr. Gustav Alde, of Gothenburg, has acted as consultant architect. Dr. Kaempe has been the naval architect for the Elsinore Shipbuilding Company.

On her air-conditioned bridge the "Venus" is equipped with modern aids to navigation, such as Sperry Gyropilot connected to the Hastie steering telemotor wheel, Sperry radar, automatic fire-detecting system with T. M. Malling master detector, Stone control of watertight doors, echo sound depth recorder, &c. The Schat (of Utrecht) system of lowering boats by one controller is installed. There are five boats per side. All are lowered simultaneously by a single electric motor controlled from the bridge. Through gearing the motor drives five drums operating wire cables supporting the boats. The boats are lowered to A deck level for embarking passengers. Little more could be done to ensure safety at sea.

After salving the ship it was found that serious damage to the machinery was fortunately confined to the auxiliary engine compartment, which lies forward of the main engine-room. Here two of the three auxiliary diesel sets were completely smashed and the third seriously damaged. The main engines had escaped lightly. The twin ten-cylinder, four-stroke B. and W. main engines, of 4400 to 5000 s.h.p. each, were originally fitted with two superchargers per engine of the Rootes blower type, chain driven from the main engine. Chain

drive has been replaced by an electric motor placed centrally between each pair of blowers, the units being mounted on the engine-room floor. This plan has also been adopted successfully on certain land installations.

With this additional load to be met, the auxiliary engine-room has been recast. The wing oil tanks have been abolished and the engine-room now occupies the full width of the ship, thus permitting the installation of three new sets in addition to retaining one of the old three-cylinder, 180-kW sets. The new ones are of B. and W. four-stroke type of about 340kW each, thus raising the original total output from 540kW to about 1200kW. The voltage is 220 d.c. This reduction in the load on the main engines will be available primarily to ease the load on the indicator cards and reduce the temperature of the cycle. It is hoped to bring down the exhaust temperature by some 40 deg. Cent. It will also be available at times to give more power at the propellers when occasion demands.

A number of small alterations have been made in the engine-room resulting in a very up-to-date machinery lay-out. Extensive strengthening of the upper structure has been carried out with a view to reducing vibration to a minimum. Great care, too, has been taken to prevent noise from the engine-rooms penetrating into the passenger accommodation.

The new bow form gives the ship a very clean run through the water, there is very little wave making, and the water leaves the stern post with remarkably little fuss.

A fine job of work has been done by her builders, both artistically and technically, and great credit is due both to them and to her owners for their imagination and foresight.

After many delays due to the non-delivery of steel and other materials and components, "Venus" successfully underwent her acceptance trials at Elsinore on May 2nd, and then proceeded to Oslo. She was on view at London Bridge on May 10th, and on May 12th started a twice-a-week service Newcastle-Bergen.

Cold Welding

IN a previous issue* we referred briefly to some recent developments in cold welding as applied, particularly, to aluminium and copper, and we reproduced illustrations showing typical welds and the tools required to make them. Following a demonstration of cold welding technique at the Research Laboratories of the General Electric Company, Ltd., last week, we are able now to give further details of the process.

Recapitulating briefly, cold welding is a simple method of making lap welds at ordinary room temperatures by mechanical pressure alone, without the application of heat. For satisfactory results, two important conditions must be satisfied. First, the metal surfaces in contact must be completely free from contamination. Secondly, the pressure must be applied over a comparatively narrow strip in such a way that the metal can flow away from the weld at both sides, and the reduction in the combined thickness of the welded parts must be accurately controlled. Accordingly, after preparation of the mating surfaces for welding, pressure is applied through the medium of specially designed press tools mounted in a suitable press. The tools, as shown in Fig. 1, produce corresponding indentations in the specimens, resulting in union of the two workpieces, and the combined thickness at these points of indentation is an important criterion of a satisfactory weld, as explained more fully below.

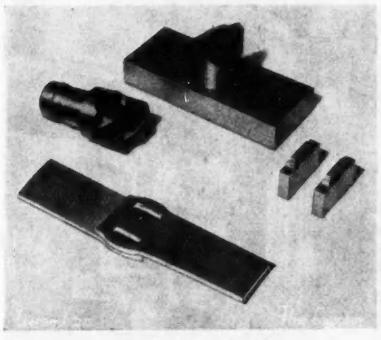


FIG. 1—SIMPLE TOOLS AND SPECIMEN WELD

MECHANISM OF COLD WELDING

Although the technique of cold welding as demonstrated to us is adequately established, theoretical knowledge of the underlying mechanism is still incomplete. Nevertheless something can be gained by comparison with the mechanism of pressure welding with heat, a process which is now quite well understood. In this form of welding the metals are worked together at a temperature which favours recrystallisation, and during this process little or no strain hardening takes place. It is thought that, generally speaking, the relative crystal size of a material not only indicates the extent of work hardening which has taken place, but actually controls the temperature at which limited recrystallisation will begin.

In cold welding the material is hardened by the work put into it, which implies that a point may be reached where crystal size is such that recrystallisation can take place at room temperature. The hardening of work during cold welding is considered to be an advantage. Although the cross section is generally decreased the loss in strength is somewhat offset by the hardening.

MATERIALS SUITABLE FOR COLD WELDING

An important criterion for cold welding, to which we have already referred briefly, is that, for satisfactory results, the combined thickness of the parts to be welded must be reduced by a certain minimum percentage which is a characteristic of the materials to be welded. Unless this reduction in thickness is achieved the weld will be imperfect; conversely, excessive reduction will weaken the welded material unduly.

Accordingly, for convenience, the "figure of merit," which has been used to compare the weldability of different materials, is the maximum percentage of the double thickness which can remain when a good weld has been made.

The table below gives the value of this figure of merit for a number of materials which have been tested in the G.E.C. Research Laboratories.

Material	Figure of Merit
Super-pure aluminium	40
Commercially pure aluminium, about	30
DTD 346 } 1½ per cent Mn	29
BA 60A } 1½ per cent Mn	20
Duralumin	20
Cadmium	16
Lead	16
Copper	14
Nickel	11
Zinc	8
Silver	6

From this table it can be seen that the most satisfactory applications are likely to be made with aluminium, aluminium alloys and copper. The remainder of the materials are not likely to be much used except in circumstances where strength is not important. An interesting fact which is at present unexplained is that the figure of merit for welding aluminium to copper is the same as for aluminium itself, whereas the corresponding value for copper to copper is only 14.

With regard to aluminium alloys the following further points are of interest. First, no more than 3 per cent of manganese or silicon can be tolerated. Secondly, heat-treatable alloys, such as duralumin, can be used in the soft condition and then allowed to harden in the usual way.

PREPARATION OF WORK SURFACE

It is extremely important that there should be direct and intimate contact between the surfaces of the metal to be welded. All surface contamination must be removed, including the film of oxide which protects the surfaces of most metals and particularly of aluminium and its alloys. Moreover, this cleaning must be done by a method which does not leave debris behind on the prepared surface. Chemical methods of cleaning are generally unsatisfactory, since they usually need to be followed by washing, whereby the oxide film is reformed. Mechanical methods, such as filing or treatment with abrasives, are also unsuitable; in filing, some of the material removed is driven back into the surface by later working; in treatment with abrasives, the final state of the surface is spoilt by the abrasive particles embedded in it.

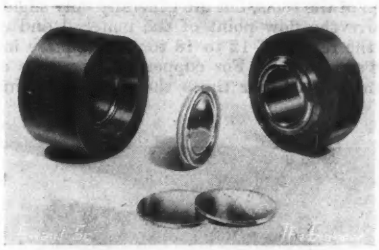


FIG. 2—RING WELD AND TOOLS

After thorough examination of the problem, it was found that consistently good welds could be obtained quite simply by using a power-driven rotary scratch brush. Steel wire brushes with a surface speed of about 3000ft/min have proved to be generally satisfactory. The work must be kept in contact with the brush long enough for the operator to feel the drag that occurs when the steel wires break through the oxide film and "bite" on the metal below. Since the brush is rotating fast the metal dust is thrown clear of the work and an open dust-free surface results. To ensure that the steel wires of the scratchbrush have their proper effect it is sometimes advisable to degrease the surface as a preliminary to scratch brushing.

Existing experience with this process indicates that, as long as the prepared surfaces are not handled, welding can be deferred for some time after surface preparation, since the oxide film is scarcely reformed within twenty-

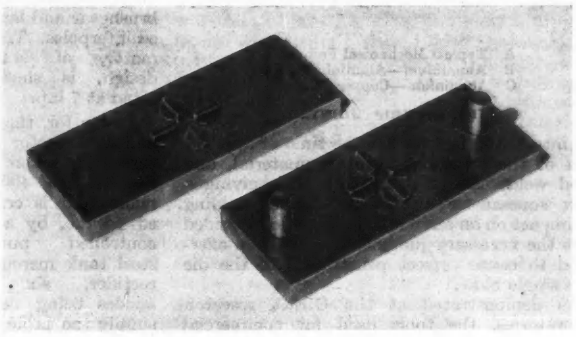


FIG. 3—PRESS TOOLS FOR STRIP JOINT

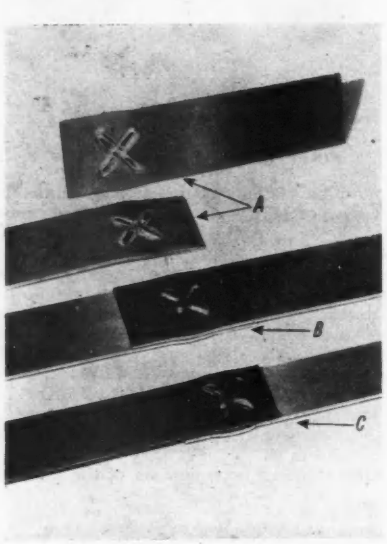
* THE ENGINEER, April 30, 1948, page 432.

four hours. Most of the welding carried out in the laboratory has, however, been done within a few minutes of surface preparation.

The Welding Process

Passing on to the welding process itself, three variations of the same basic technique have been evolved, as described in our previous article. The first is the long, straight weld, an example of which is illustrated, with the appropriate tools, in Fig. 1. The second variation is the annular or ring-weld, such as that shown, with the appropriate tools, in Fig. 2. A further variation is the process of continuous seaming, which is an obvious extension of the long, straight weld.

As mentioned above the dies must be designed to produce the necessary flow of metal and the depth of penetration must be controlled by stops or otherwise to ensure the correct residual thickness at the weld. The pressures required are related to the working area of the tools, but are generally only slightly above the flow point of the material and are in the region of 12 to 18 tons per square inch for aluminium. For copper the pressures are from two to four times those for aluminium.



A Typical Mechanical Failure
B Aluminium—Aluminium Joint
C Aluminium—Copper Joint

Fig. 4—Strip Joints

An interesting fact is that the time of application of the pressure is quite immaterial, and good welds can be made with tools giving a slow squeeze or an impact. Hand-welding by impact on an anvil is quite feasible, provided that the necessary judgment and skill is exercised to cause correct penetration of the die at a single blow.

As demonstrated at the G.E.C. research laboratories, the tools used for commercial purity aluminium are made of mild steel. A chrome-manganese tool steel has also been found suitable and there is no need for this to be hardened. The only pick-up of material by the tools which has been observed is a slight surface contamination almost equivalent to a thin plating. Die-wear does not appear to be a likely cause of trouble and the work done so far has produced very little evidence of wear even in those dies which have been most extensively used.

Strength of Weld

As mentioned above, work-hardening has the effect of improving the strength of the welded metal. For example half-hard commercial purity aluminium is stated to reach an ultimate tensile strength, after welding, of 22,000 lb per square inch, i.e., about twice its original strength. Clearly the strength of a weld depends on its shape and size. At its weakest (where the length of the weld lies across the strip) the residual material has about a quarter of the original total thickness, but, being work-hardened and twice as strong as the original material, the welded piece will be half as strong as the original strip. By a judicious design of the welds it is possible to arrange that the joint is as strong as the original section. For instance, an aluminium joint, such as that shown at A and B Fig. 4, was tested to destruction in a tensile testing machine. In the demonstration which we witnessed failure of the joint occurred at a load of 1·7 tons, whereas the original strip, tested under similar conditions, fractured at 1·8 tons. The press tool for making this form of strip joint is shown in Fig. 3.

Some indication of the possible applications and scope of cold welding has already been given. The technique for copper to aluminium welds may prove to be useful in making electrical contacts and connections and methods have been developed for joining wires. Tests have been made to measure the contact resistance and burn-out current of various welds. A demonstration of one such test, on an aluminium to aluminium strip specimen similar to that shown in Fig. 1, revealed that burn-out occurs in the parent metal, the joint having a resistance of about 80 per cent of the unwelded material.

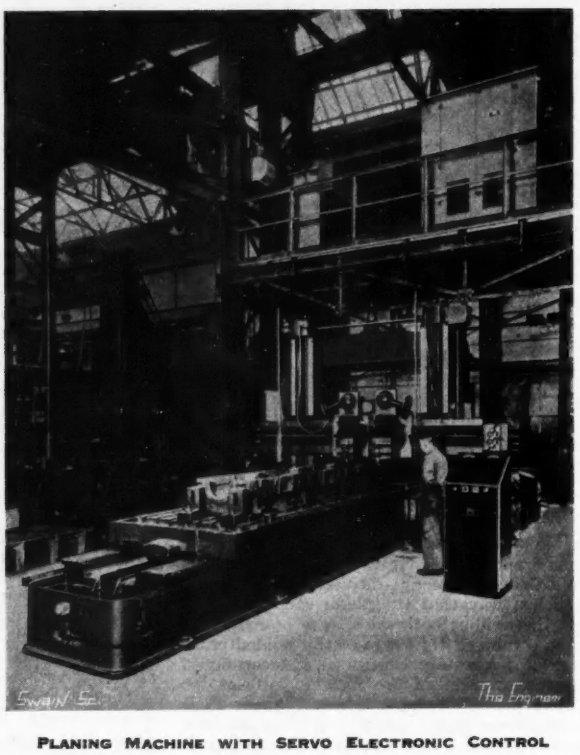
Servo Electronic Control of a Large Planing Machine

THE installation of a large new planer at the Witton engineering works of the General Electric Company, Ltd., gave the company's electronic engineers the opportunity of equipping this machine with a newly developed servo-electronic system of power conversion and control. Servo electronic control is a device whereby the motor speed is compelled to conform with an adjustable standard in a way which is analogous to control of a gun by its director. The system, which is briefly described in this article, is believed to be the first comprehensive application of electronics to planer drives, which fall within the medium power range.

Our first illustration gives a general view of the planer, with its control equipment. The table of the planer is 5ft by 14ft, the main table motor being a d.c. machine rated at 9/50/50 h.p. at 69/400/620 r.p.m. This motor is specially designed for reversing duty, having radial brushgear and laminated interpoles. The feed motor, of standard design, is short-time rated at 7 h.p.

Power for the table and feed motor armatures is taken from the 3-phase, 400V a.c. mains and is converted to d.c. by a grid-controlled pumpless steel tank mercury arc rectifier, six main anodes being used to supply the table motor and two auxiliary anodes, not grid-controlled, to supply the feed motor. The rectifier and its associated equipment are housed in a main control cubicle, which is mounted on a gallery above the planer, as illustrated opposite. Another photograph, reproduced herewith, shows the control cubicle with its cover removed. The six main anodes are controlled by a static phase controlling network and servo-amplifier, whose input references are regulated by four potentiometers on a control desk. In either direction the speed of the table can be preset independently. The amplifier also provides an overriding current servo-control, which limits the maximum current in the motor armature. This current is under the control of the operator over a restricted range and therefore overloads beyond the preset value are impossible.

Reversal of the planer table is effected by reversing contactors in the motor armature circuit. During this part of the cycle the current is constant and limited to the maximum value preset by the operator. While the table is being retarded, the rectifier functions as an inverter and the energy stored in the moving masses is returned to the mains. Control is provided so that the table can be accelerated to a high speed between cuts in cases where widely separated surfaces are being machined: this part of the cycle of operation is usually termed "air cutting."



Planing Machine with Servo Electronic Control

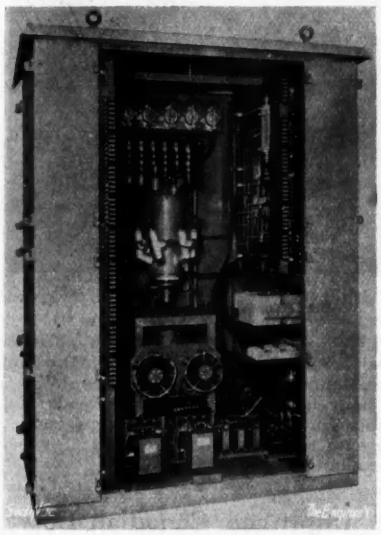
An interrupter is fitted to the shaft of the feed motor armature so that the revolutions made by the feed motor in one cycle of operation are automatically counted. The number of revolutions, and therefore the feed travel of the tool holder, can be preset by means of a stud switch on the control desk. A two-speed gearbox is incorporated in the drive from the feed motor to the tool holders, and feed ranges of 1/64in to 3/16in on fine gear and ¼in to 1½in on coarse gear are provided, each range having ten steps, which can be preset at the control desk. Pressing a traverse button causes the feed motor to run

continuously in the direction opposite to that of normal feed for as long as the button is held depressed.

Control Desk

The controls for setting up the machine are mounted on the control desk, which appears to the right of the planer in the general view of the equipment; a separate illustration shows details of the control desk with the front cover removed. The desk is of sheet metal construction, and the operating controls comprise two push-button pendants, one on each side of the machine, which can thus be controlled from either side of the table. Push buttons are provided for start, stop, inch cut, inch return, feed "on," feed "off," traverse and emergency stop. On the control desk are mounted four potentiometers, six rotary switches, one multi-stud switch, two push buttons, two pilot lamps, ammeter, voltmeter.

The function of the potentiometers is to allow the operator to control the setting of the forward and return speeds, the ceiling speed



Main Control Cubicle

(during air-cutting or acceleration) and the maximum armature current of the table motor.

The rotary switches are provided so that: (*a*) the acceleration or air-cutting features can be switched in or out of circuit; (*b*) the return speed of the table can either be controlled by its potentiometer or remain the same as the cutting speed, and (*c*) each of the tool-relieving solenoids which lift the tool clear of the work during the return stroke of the table may be switched on or off.

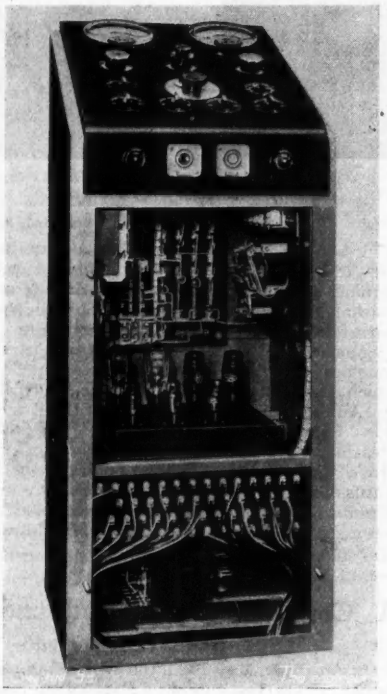
Feed selection is done by the multi-stud switch, which fixes the distance moved by the tool holder during each cycle of the table. The push buttons control the master "on" and "off" contactor, and are used respectively when first starting and finally shutting down the equipment.

Limit switches are fitted to the tool holders on the planer itself to safeguard the machine against damage should the tool holders be accidentally driven against each other or to the ends of their slides. The limit switches can be rendered inoperative by a push button at the side of the bed, thus allowing the tool holder to be traversed in the reverse direction after the limit switch has operated. Four further emergency stop buttons are fitted in suitable positions about the machine.

The equipment is started by pressing the "on" button on the control desk. This ignites the rectifier and energises all auxiliary circuits, but leaves the table motor locked "out." A red pilot lamp glows as soon as the start button is depressed. After an automatically timed interval of one minute to allow the amplifier valves to heat up, a green pilot lamp glows, indicating that the machine may be started. During normal operation the red pilot light "winks" with each movement of the feed, a novel and effective indication that the control system is operating. If, by accident, more than one button is pressed at the same time no damage is caused to the equipment nor does the protective gear come into operation. This is an important safety feature.

A number of important advantages are claimed for this particular kind of servo electronic drive, compared with the familiar Ward-Leonard system of control. First, the rectifier conversion efficiency is higher, particularly at medium and low loads. This results in a considerable saving in energy since the table is almost invariably unloaded during the return stroke, and very few cutting operations call for maximum h.p. from the motor. Secondly, due to the use of a maximum current limit type of servo control, the torque of the table motor during reversal and acceleration remains substantially constant instead of being "peaked," so that both the electrical and mechanical stresses on the equipment are lower for the same average rate of change of table speed than the equivalent stresses on a Ward-Leonard drive.

Again, the extremely rapid response of the servo-electronic control gives very rapid acceleration of the table when "air-cutting," so



Control Desk

that it is practicable to use this device for shorter travels than has hitherto been possible. At any given setting, overrun is controlled with great accuracy and uniformity. All controls, including the feed selection, can be operated while the table is in motion, and no injury can be caused by a too rapid manipulation of the speed controls.

From the installation point of view, the static power unit is attractive as it requires no special foundations and can be mounted overhead to save floor space if desired. Maintenance work is reduced to a minimum by using static converting plant instead of rotating parts and by the special arrangement of the reversing contactors, which control a circuit having negligible inductance, and which open and close with practically zero current flowing in the main contacts, thus reducing contact wear to a minimum. The control amplifier is provided with a multi-pin connection and in the unlikely event of a spare being required, it can be inserted in a few minutes. The remaining gear calls for no special electronic knowledge on the part of the maintenance staff.

Midland Advisory Council on Industrial Productivity

A conference arranged by the newly-formed Midland Advisory Council on Industrial Productivity was held at Birmingham University on Friday last, May 28th. The council consists of representatives of Birmingham University, the Birmingham Chamber of Commerce, the Midland Region of the Federation of British Industries, the Central Technical College, the Midland Regional Board for Industry, the Midland Trade Unions, Professional Institutions, and Research Associations, and is the outcome of discussions which have taken place recently between these organisations.

The council's first objective, it may be explained, relates directly to the need for securing the maximum possible increase in industrial productivity, on a short-term basis, as the only available method of restoring national economic stability at the present time. The second aim is the equally important one of developing, on a long-term basis, means for closer liaison between the university and other educational and research institutions and Midland industries, with a view to facilitating continuous improvements in industrial productivity and in standards of living through education and training and the more rapid application of science in industry.

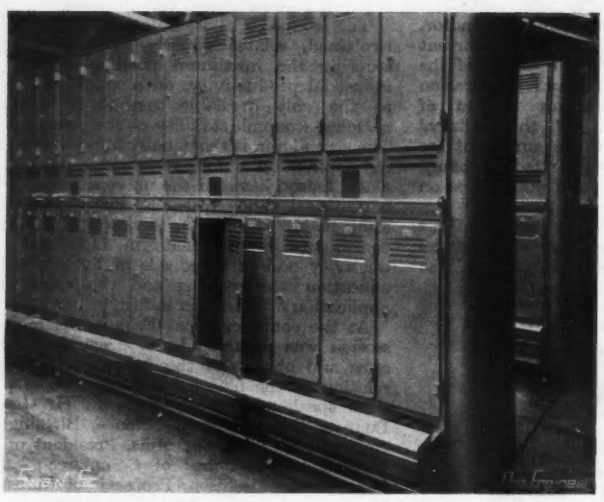
At the conference last Friday, the morning session was occupied by a discussion of the aims and objects of the Advisory Council in relation to the national situation. The principal speakers were Professor F. H. Garner, Dean of the Faculty of Science, Birmingham University; Sir Percy Mills, President of the Birmingham Chamber of Commerce; Professor Leslie Aitchison, Professor of Industrial Metallurgy, Birmingham University; Sir George Schuster, Chairman of the Industrial Productivity Committee's Human Factor Panel; Professor T. U. Matthew, Department of Engineering Production, Birmingham University; Mr. F. B. White, Institution of Production Engineers; Mr. G. Basil King, Midland Regional Board for Industry, and Mr. O. F. Brown, of the D.S.I.R.

In the afternoon the subject for discussion was "Short Term Methods of Increasing Industrial Productivity." The speakers included Sir Arthur Smout, Vice-President of the Birmingham Chamber of Commerce, who compared the industrial productivity of Britain with that of the U.S.A., where, he said, it was 68 per cent greater than in 1939. That increase in the U.S.A. did not reflect, he thought, any change in the effort of the workers, but had been brought about by improvements introduced by managements in making use of the materials and methods evolved by scientists and technicians. There was nothing about American industry which this country, with its resources of technical knowledge, could not equal and surpass, and if we were prepared and permitted to spend money on the improvement and modernisation of plant, and applied ourselves to the task, there was, Sir Arthur considered, no reason to fear. In expressing his belief that the future of British industry depended upon improved production methods, Sir Arthur emphasised that much could be done by a tuning-up and periodic overhaul. It was important that the best use should be made of the labour and equipment available, and he thought there was a good deal to be said for "methods men," who would constantly challenge and overhaul works practices.

Other speakers during the afternoon session were Lord Sempill, Mr. J. J. Gracie, Mr. J. Wilson, Mr. N. Pleming, Mr. E. L. G. Robbins, Mr. T. Kirkham, and Mr. J. Bolas, and before the proceedings ended the conference agreed to the appointment of an executive committee of the council. Mr. J. J. Gracie is the chairman of the committee, the other members being Sir Arthur Smout, Sir Anthony Bowlby, Mr. F. Garner, Mr. J. Bolas, Professor Leslie Aitchison, and Professor T. U. Matthew. Dr. R. E. Priestley, Vice-Chancellor of Birmingham University, is President of the Council, and Sir Percy H. Mills, Vice-President. Mr. F. J. Winfield, of the Birmingham Chamber of Commerce, is honorary secretary.

Foundry Welfare in Sheffield

On Thursday, May 27th, we were invited by the directors of the Brightside Foundry and Engineering Company, Ltd., of Sheffield, to visit the company's Newhall Works, and inspect the foundry and roll turning shops and the new welfare centre, which, it is believed, is one of the best of its kind installed in a specialised foundry. As will be seen from the accompanying engravings, the centre provides clothes locker accommodation and washing and bathing facilities for the employees. Each man has the use of two lockers, one to accommodate his clean clothes and another for his working clothes. Each locker is about 1 yard in height, with a width and depth of about 1ft. They are individually ventilated and heated, and the fittings included, we noted, coat-hooks and a soap tray. The tiled washing-room, of which a view is herewith given, has seven shower cubicles and two foot-baths, each of which is equipped with hot and cold water supplies. A mixing valve facilitates temperature regulation. The central heating for the welfare centre is supplied by a sectional boiler having a designed output of 625,000 B.Th.U.s per hour. The same boiler is utilised to heat the canteen and stores, which are in close proximity, and to maintain a regulated temperature throughout the washing-rooms of 70 deg. Fah.



CLOTHES LOCKERS

WASH ROOM

A 200-gallon capacity copper calorifier supplies hot water at about 150 deg. Fah. to the various draw-off points and a standby boiler for summer use is connected to the calorifier system. The drying-room for wet clothes is heated by a hot water circulating system, the water being circulated through the clothes rails. In this room the air is moved at the rate of 20,000 cubic feet per hour. The rooms described are daily disinfected. We were pleased to learn that the new centre, since it has been put into commission, is used by nearly 80 per cent of the foundry workers, and the hope is expressed that shortly it will be fully used. The installation was entirely designed and carried out by the heating and air treatment division of the company.

The foundry consists of three bays for heavy work, roll casting, and the melting equipment. The heavy bay has a length of 260ft and a width of 51ft. We were present at the pouring of a heavy ingot mould casting of octagonal shape, having a length of 11ft 8in and a wall thickness of 12in, weighing about 65 tons. The bay is served by an overhead travelling crane of 150 tons capacity, and two 35-ton cranes and one 10-ton crane. Completed castings of stamp blocks, ingot moulds and rolls and hydraulic rams were seen. The melting equipment, which furnished some 80 to 90 tons of molten metal for the ingot mould cast, comprises two pulverised fuel reverberatory furnaces to charged, a Sesci rotating furnace, and four cupolas, two of 10 tons and two of 5 tons capacity. There is a gas-fired annealing furnace in the equipment bay. The roll bay and the equipment bay are 118ft and 185ft in length respectively, and each has a width of 55ft. The roll bay is served by two 25-ton cranes. A large variety of rolls for the steel and non-ferrous metal industries and for many textile, paint, chemical, and food industries were seen in the foundry and in the roll turning and grinding shop. That shop has two bays with a total area of 78,660 square feet, which are served by overhead travelling cranes of 25 tons, 10 tons and 5 tons capacities. The machine shops are well equipped with turning and boring lathes and grinding and finishing machines. Adjoining the roll shop is the fettling and the despatch department.

Some of the visitors also went out to the company's Ecclesfield works. At a luncheon which was held at the Grand Hotel, Sheffield, Mr. Ambrose Firth, the chairman of the Brightside Foundry and Engineering Company, presided, and gave a short history of the firm's works, and its efforts to improve the status of the foundry worker and to attract new recruits. Thanks were expressed on behalf of the guests by The Master Cutler, Mr. Edward W. Senior.

A Conference on Production Per Man-Hour

On Saturday, May 22nd, the Wolverhampton section of the Institution of Production Engineers held a conference on production per man-hour at the Wolverhampton and Staffordshire Technical College. The conference was opened by the Mayor of Wolverhampton and following his welcome to the guests, Major J. Freeman, Joint Parliamentary Secretary to the Ministry of Supply, gave a short address on "The Importance of 'Production per Man-Hour' to the Nation." He stressed the importance of efficient planning at an early stage of any project and the need for adhering to that plan. In any industrial project for reorganisation or improvement of production it was of vital importance to consider human nature. Major Freeman was convinced that the difference between success and failure in all projects intended to lead to an increase in production depended on whether or not sufficient account was taken of the human element. He said that what must be impressed upon the worker was that so far from creating unemployment by increasing production, which was the fear he had in the years before the war, he would have to face the possibility of unemployment only if he failed to give the production which was necessary to keep our industrial machine going at full pressure.

The next speaker was Monsieur Robert Caussin, who presented an interesting paper on "Belgium's Contribution to Production Per Man-Hour." Miss A. G. Shaw, the President of the Motion Study Society of Great Britain, then gave an address on the application of motion study to machining assembly and handling of materials. The American viewpoint on Britain's problems was dealt with in an address by J. Y. Scott, entitled "America's Contribution to Production Per Man-Hour." The final address to the conference, before a discussion was opened by Professor T. U. Matthew, was given by Mr. B. H. Dyson, who dealt with "The Practical Side of 'Production Per Man-Hour' in Production Shops."

Many interesting points were made in the papers presented to the conference and we hope to report abridged versions of some of them in the near future.

Improved Canadian Log Barker

Powell River Company, Ltd., British Columbia, in the interests of conserving timber resources, has been experimenting for some time with the use of small logs in the manufacture of pulp and paper. The results of these experiments is the installation of a small log barker. Like its larger counterpart, the large hydraulic barker, which the company put into operation early last year, the small log barker strips the bark from the logs by use of high-pressure water jets. Logs as small as 4in in diameter can now be utilised, which means that the small trees, tops of the larger trees, and even limbs from some of the larger trees can be used in the manufacture of pulp and paper. The use of these two hydraulic barker installations has reduced log consumption per ton of paper by as much as 12 per cent. Accompanying the barker operation is the installation of the whole log chipper. An almost unbelievable operation, the chipper can reduce a 30in log, 26ft long, to small uniform chips in a matter of thirty seconds. This is a vastly different picture from the old method of chipping whereby the logs had to be sawn, cut into blocks 32in in length, barked, and then fed into individual chipping machines. The new chipper installation covers the entire process in one operation. There is no waste, no small butt ends to discard; the entire log is consumed.

Institution of Naval Architects.—A research scholarship of the value of £400 per annum and tenable for two years has been offered by the Aluminium Development Association to encourage and facilitate research in the application of light alloys to ship construction. The scholarship will be administered by a committee of the Institution of Naval Architects, and it is hoped to make the award in September, 1948.

Literature

The Amateur's Lathe, by L. H. SPAREY.—The Drysdale Press. Price 12s. 6d.

IN its class this is an excellent book, clearly written and copiously illustrated. We commend it without hesitation to amateurs and others who either need guidance in lathe work or who, being experienced, enjoy hearing what another expert has to say. Amongst the latter we venture to place ourselves. We have passed several pleasant hours with this volume and such comments as we have to make upon it are just those that we should make were we, happily, talking shop to the author.

Let us say, first, that it goes right through amateur metal lathe work from A to Z. That means a lot, for the amatéur lathe has to be a jack-of-all-trades, ready to take on a job of drilling or milling, and even shaping and other odd jobs, as its proper functions of turning and boring. Mr. Sparey covers the whole field and the advice he gives is always sound.

The author has a good deal to say very usefully about drilling but oddly enough he does not mention the sharpening of twist drills in home workshops. He very rightly insists upon drills being kept in condition and discusses the form they should have for different materials. Moreover, he describes the familiar method of touching up the points of a drill with a fine hone for finishing a hole to dead size. Now the amateur has not an unlimited supply of drills. Probably one of each size has to play many parts and frequent changes of form alarm him. We should have been glad to hear how a man of Mr. Sparey's practical experience tackles the job of sharpening twist drills from say 1/32in up to 3/16in.

He mentions a cement for chucking thin discs. It appears to be that very old friend of the turner—Chatterton's Compound, still obtainable in tool shops. He speaks also of mounting thin discs with shellac. Shellac is largely used by instrument makers. They warm the chuck, invariably of metal, rub a stick of shellac on it and press the blank into contact. The work is then done whilst the chuck is still warm. As soon as it gets cold the shellac becomes brittle and the blank can be knocked off with a sharp tap.

On the matter of parting-off the author does not allude to parting-off with a hack-saw; possibly he does not approve of that practice. But it is a great economiser of material and temper. Thin parting tools are very liable to break and if they are substantial are several times as thick as a fine hack-saw. The only objection is that the saw does not leave a fine finish, but that is only of consequence in special cases—like making washers or nuts.

There is no mention of case-hardening in the index and we have failed to find any discussion of its value in the text. Indeed, it seems to be a practice too little used by amateur tool makers. Yet it has great merits and few drawbacks for certain classes of work; it is unexcelled for broaches, for small gear-cutters and mills, and so on, because it gives a dead hard edge on a mild steel backing and there is little or no fear of cracking or distortion when hardening.

Mr. Sparey gives a short chapter on spinning, but we fear his heart was not in it. Actually it is a fascinating technique, useful for all sorts of odd jobs and the amateur is advised to get the admirable pamphlet on the subject published by the Wrought Light Alloys Development Association of Birmingham. The author's advice to anneal aluminium by heating to redness and quenching in water must be accepted with caution. The right temperature is about 360 deg. Cent. (680 deg. Fah.)—far below cherry red; some aluminium alloys fall to bits at high temperatures.

One more gentle criticism. The author describes an indexing device which employs a train of gears. Surely that is poor practice! The less mechanism between the indexing plate and the work the better; even the usual wormwheel departs from true perfection of the method of indexing on the spindle itself.

There are many other little matters in this valuable book that we could chat about very happily. But we must leave it now, renewing our recommendation to amateurs to get it and keep it.

Breathing in Irrespirable Atmospheres. By Sir ROBERT H. DAVIS, F.R.S.A. London: Saint Catherine Press, Ltd., 29, Great Queen Street, W.C.2. Price 25s. net.

FEW men are more qualified to write a book upon this subject than Sir Robert Davis, who has devoted a lifetime in the development of breathing apparatus. To such men as Sir Robert, the late Professor J. S. Haldane, Professor J. B. S. Haldane, Sir Leonard Hill and Dr. Leonard Levy, science and industry owe a debt beyond measure for the work they have done in providing means of saving and protecting life under conditions where normal or safe breathing is impossible. This book is a record of much of this work, and, although the reader is only given but brief glimpses of the difficulties and dangers which accompanied the development of the many forms of apparatus now available, the achievements of these and other pioneers are faithfully described.

The book is complementary to the author's earlier work on "Deep Diving and Submarine Operations," in so far as it deals only briefly with underwater breathing apparatus.

It opens with an interesting historical chapter showing how the offensive weapons used by wild animals are analogous to those employed by primitive man, and how even poison gas has its counterparts in the animal world. Early uses of gas and incendiaries in warfare are described and their development up to the present day is traced in a very interesting way. Following chapters deal with the physiology of respiration; oxygen, helium and charcoal. A short history of early research carried out in breathing at high altitudes concludes with the more recent achievements in this direction. Closely associated with the subject of breathing is that of resuscitation and a section of the book is devoted to describing some of the earlier methods and their modern counterparts.

Before dealing with the modern forms of breathing apparatus, the author describes in some detail the origin and development of breathing appliances during the past century—from the natural smoke filter formed by the old-fashioned fireman's whiskers, to the later self-contained oxygen and compressed air units. The book concludes with accounts of some mine rescue and recovery operations, which are designed to show the important part modern breathing appliances play in this very important industry.

We found this volume both interesting and informative, and its many excellent illustrations, coupled with a clear, lucid style of writing, make it a worthy record of a great achievement by virtue of which some of the greatest hazards of nature and industry have been overcome.

Concrete and Contractors. By Noel D. Green, A.G.G.I., A.M.I.Mech.E., A.M.I. Plant E. London: Crosby, Lockwood and Son, Ltd. Price 12s. 6d. net.

THIS is just the book a contractor would like to give to his son or to an apprentice. It explains in simple language most of what such a young man ought to learn from a book. It expresses in very clear terms the facts upon which the successful production is based and, whilst it is essentially an elementary treatment of the subject, it is very pleasantly and definitely practical. The illustrations are all in the form of drawings and diagrams and so are much clearer than most photographs. Though the drawings are in relatively coarse lines, this does not in any way lessen their effectiveness.

The author has clearly endeavoured to explain some of the theories underlying the modern methods of controlling the properties of concrete and to give some advice on the best way to use modern plant and he has largely succeeded. He has borne in mind the importance of making concrete *profitably* and explains several ways in which losses are easily caused.

There are twelve chapters—all useful and informative—of which the best are "How Much Water," "The Testing of Concrete," "Is Control Practicable?", and "Future Developments." There are several useful tables and an Appendix of Useful Data.

The author emphasises the importance of stating the *weight* of the cement in pounds to each cubic yard of concrete instead of specifying the volumes of the cement, aggregate and sand. Indeed, he states definitely that the former is the only accurate and satisfactory method!

He makes some interesting statements about waterproofing concrete and is of the opinion—based on his experience—that waterproofers are not required by careful contractors. There is a useful little section on defective concrete, another on patching, and still another on refractory concretes.

The chapter on "Is Control Practicable?" contains much useful information, but it is to be hoped that, when a new edition is published, this chapter may be completed in such a manner as to show more definitely the precise manner in which control is practicable. In the present edition the subject is left too indefinite and the use of logarithmic equations without any explanation is beyond the grasp of most contractors.

The chapter on concreting plant is a very practical one, but it could be made much more effective if it were half as long again and so able to include more details.

The chapter on "The Choice of Aggregate" contains several small slips and obscure or ambiguous expressions; some paragraphs in this and other chapters would be improved by rearrangement, but, though puzzling to some readers, these defects are not really serious and can easily be corrected when another edition is published.

In short, whilst the book, as already stated, is particularly suitable for a contractor to give to his son or apprentice most wise contractors would first read it themselves and would learn a good deal by so doing.

THE ENGINEER

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NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

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CONSULTANTS AND PUBLICITY

AT the annual luncheon of the Association of Consulting Engineers last week, Mr. Noel Baker, Secretary for Commonwealth Relations, imagined what engineers would be capable of doing if only a period of ensured peace could succeed in the latter half of this century to the epoch of wars and disturbed international relations that has characterised its first half. He quoted "an American engineer" (was it, perhaps, Mr. Lilienthal of the T.V.A.?) as saying that there were some 1200 rivers in the world that could be treated like the Tennessee valley. He suggested that, properly irrigated and developed, Iraq could maintain a population four times bigger than the existing one at higher living standards and that Rhodesia could produce ten times or even twenty times as much food as is now grown there. Great developments were not only possible but necessary in India and Pakistan to support their growing populations. Nearer home he thought the Sahara could be irrigated and that a great electricity grid centred on the Alps could be spread over Europe. Engineers, of course, know such things to be possible if the manpower and the finance to build the necessary works became available and peace ruled on the earth. But at present they are no more than plans, vague, perhaps, but little more vague than others of narrower scope and somewhat greater detail that were worked out hopefully by all the nations of the earth during the war years.

More plans have been studied recently than could under any conceivable usage of existing manpower be carried to reality under a term of decades, if not of centuries. Yet we suppose it is better to have planned and pigeon-holed than never to have planned at all! For some, at least, of the plans will be carried out, and in the conversion of paper schemes to reality we can hope that much work will be brought from abroad to the consulting and contracting engineers of this country. Indeed, had such plans been made a few decades ago we should have been fully confident that British engineers would be entrusted with nearly all of them. For then over great parts of the earth—in India, Egypt, the Near East and even the Far East, not to mention the developing Dominions—British engineers were employed under the British flag, and other nations naturally came to Britain as the only land in which wise advice on the carrying out of the greater engineering works was to be found. But in these later years, particularly from across the Atlantic, competition has developed. American engineers, having built great and highly publicised civil and other engineering works in their own land, are now seeking work abroad with the prestige of those achievements behind them. It was, no doubt, with that thought in mind that Mr. Noel Baker referred also to those rules of etiquette that limit the actions of British engineers in certain directions and asked whether they ought still to apply in their full rigour at a time when it is very desirable that this country should export brains as well as goods. Would British consulting engineers be better able to compete were they less hedged about in their actions by ethical considerations? The Association and the technical institutions—we have no doubt whatever upon the point—will certainly continue to support the maintenance of etiquette, whether it is specifically laid down by rules, as it is for some engineers, or supported only by a high, but unwritten, conception of professional conduct, as it is for others. For amongst consultants (with whose interests this discussion is more particularly concerned) there must be few, if indeed any, who desire to see any significant change, certainly not a change that would open the door to self-advertisement and direct competition for specific jobs. It may, indeed, be, as the chairman, Dr. J. F. Crowley, pointed out at the lunch, that the nationals of other countries sometimes find the restraint exercised by British consultants difficult to understand. But it has to be remembered that those nationals have, at least, no doubts whatever about the integrity and good faith of our consultants. The British name is linked abroad with a very high reputation for scrupulously fair dealing. It is, of course, high ethical standards, finding expression in rules of etiquette, that support that integrity; and any substantial relaxation could in the longer run only do harm to a reputation whose value, though imponderable, is unquestionably immense.

Yet the fact remains true, and it was no doubt in Mr. Noel Baker's mind in raising the issue, that, especially in comparison with American achievements, those of British engineers, carried out in all parts of the world and often in the face of difficulties that would not be experienced in better developed lands are not as well known abroad (or even in this country) as they should be. We believe that British engineers, modest though they are, must needs become more conscious that publicity given to any individual work benefits not the one consultant alone, but raises the prestige of British engineers as a whole. But is it possible that ethical standards which require a nice distinction to be drawn between what is and what is not self-advertisement sometimes discourage consultants from taking much interest in publicising their work? We understand that a small *ad hoc* committee now has the whole question of ethical standards in the engineering profession under review. We hope that the matter of ethics as affecting publicity will receive its due meed of attention.

AMERICAN AND EUROPEAN PRODUCTIVE METHODS

FROM time to time, these many years past, industrialists from this country have gone across the Atlantic and have come back filled with enthusiasm for American productive methods and critical of the slower tempo and lesser production per man-hour of British industry. Similarly, American engineers and others have come to this country and have been shocked to find in use productive methods that seem so far behind their own. They have returned to their own land to preach the technological decadence of Britain. This process of criticism still continues. One of its latest products is a publication of the Machinery and Allied Products Institute of Chicago, entitled "Technological Stagnation in Great Britain," whose object is to hold up the state of British industry before American eyes as an awful warning of "impending horrors, threatening hideous fall." It is held that "the economic difficulties in which Great Britain now finds herself are due in no small measure to the backwardness of her productive technology" and that "the significance of British experience for this country [the U.S.A.] gains emphasis from the fact evident to anyone who studies the record, that we are by no means immune to the degenerative processes that have sapped the vitality of industry overseas." The real purpose of the publication (which appears to be not without some political flavour) is, judging by its Foreword, to prevent the U.S.A. from repeating that degenerative process.

With such an object in view it is too much to expect that the authors should have retained a wholly balanced sense. In fact, much of the work consists of quotations from and comments upon the "juicier" bits of Working Party reports upon British industries. Nevertheless, as an epitome of American criticism of British and, indeed, European productive methods as a whole, the publication is worth perusal. Part of its contents consists of a somewhat disturbing comparison of output per worker for various industries in this country and in the United States, and it is stated that "American man-hour output ranges from 131 to 597 per cent of the British." Such comparisons are, of course, always dangerous. For the statistical information upon which they are based is seldom complete, and even when reasonably reliable information is available it is never certain that the figures obtained from different countries are in reality truly

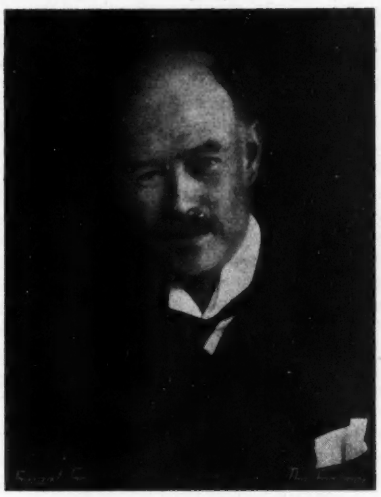
comparable. Yet even if the figures given in this publication probably give a view distorted in that direction which best serves to emphasise the authors' point, it is undoubtedly true that overall output per man in this country is very appreciably lower than that in America. What is far less certain is whether lower figures for output here necessarily indicate industrial stagnation. For other factors have to be taken into account. For instance, the Reid Report, quoted in this American document, credited American coal-miners with an output per man-shift of 8740 lb as compared with a corresponding figure of only 2350 lb for Britain. But Mr. Young, in the report he issued on his recent return from a visit to American coalfields, remarks that American conditions "are as different from ours as chalk is from cheese." Direct unqualified comparison, in fact, as we have again and again pointed out in these pages, and as Sir Richard Redmayne again emphasises in an article in this issue, always gives for this industry a misleading impression. Nor are similar differences absent in other industries. In the engineering industry, for instance, big differences of circumstance have to be noted and allowed for if true comparisons are to be made. Particularly important is the influence of the market on productive methods. Where the British manufacturer is blessed like the American with a large and assured market, as, for instance, ball and roller bearing makers are, productive methods and output per man-hour on the two sides of the Atlantic are closely comparable. But many markets for British goods appear more selective than that in which American manufacturers deal — predominantly their own home market. There are, for instance, to epitomise the difference, several American car manufacturers, but, broadly, only one type of American car; by contrast Europeans and other nationals demand a wide range of cars from high-powered limousines to low-powered "babies" and from "sports models" to "family saloons." Britain, manufacturing for the world rather than for its home market alone, has to take into account such national tastes and likings. The consequence is that mass production methods cannot be so highly developed as in America, and output per worker is necessarily lower. Furthermore, many of the heavier engineering products of this country are made to special orders and designs, so that not even group productive methods are applicable. Such considerations have effects so important upon the design, development, equipment and lay-out of factories that it is not surprising to find great differences between American and British practice.

For criticism to be effective it must take into account all the factors concerned. That, the publication under review conspicuously fails to do. We feel, therefore, that if British productive methods are to be criticised—and there is undoubtedly much in many British industries that is open to criticism—we prefer to go back to those Working Party reports upon which this American publication is so largely based. For we do not believe this country technologically decadent. All the evidence of the war years and the many devices invented, developed and manufactured here during those years weigh against that view. Moreover, there is now going on, up and down the country, much rebuilding and extension of factories and works on modern lines. Undoubtedly there is much that can and should be done in this country to raise output per man-hour and cheapen cost, thereby raising our standard of living; and in seeking ways of achieving that end there is much that we can learn from America. But productive methods on the two sides of the Atlantic can only be similar for a limited range of goods. For whilst American manufacturers make predominantly for a great home market, Britain must continue to manufacture for a world-wide export market. In consequence, Britain will need in the future, as in the past, to make goods of high quality specially designed to suit the purposes for which they are made, and the markets to which they are sent. In such circumstances we doubt whether that standardisation of design which is favourable to high productivity can ever be carried so far in many of our factories as it can be and will be across the Atlantic.

Obituary

SIR WILLIAM MURRAY MORRISON

It is with deep regret that we have to record the death, which took place in London on Friday, May 21st, of Sir William Murray Morrison, late managing director of The British Aluminium Company, Ltd., and the



SIR W. MURRAY MORRISON

Lochaber Power Company. He took a leading part in the early development and the establishment of the aluminium industry in Great Britain. Sir William, who was in his seventy-fifth year, was the son of the late Mr. William Morrison, of Birchwood, Inverness, who was a shipowner engaged in the coal business. Young Morrison received his early education at Inverness College and continued his studies in the University of Edinburgh. Later he studied at the West of Scotland Technical College in Glasgow, where he came under the influence of the late Lord Kelvin. After qualifying in civil and electrical engineering, he practised in the North of Scotland for a short period and in 1894 he joined the British Aluminium Company, Ltd., some four months after its formation, as resident engineer at Foyers.

It will be recalled that one of the first hydro-electric plants in this country was installed at Foyers for the manufacture of aluminium by the then new Hall-Héroult process by the electrolysis of alumina in a bath of melted cryolite. Without having previous technical knowledge or experience of the process, Murray Morrison was entrusted with the task of developing and improving it in every way possible. Lord Kelvin was consultant to the company and, at his request, Mr. Morrison was joint technical adviser with Lord Kelvin.

The success achieved at Foyers was such that in 1907 the temporary factory at Kinlochleven was extended and power plant and furnaces installed, and in 1909 it was a permanent reduction plant. Later on the potentialities of hydro-electric plant in Scotland were carefully surveyed and he planned the scheme which ultimately led to the formation of the Lochaber Power Company, and the large-scale production of aluminium metal in Scotland. Lochaber began production about 1930, and with all the company's Highland reduction plants the annual output of aluminium metal rose from about 300 tons at Foyers in the early days to 30,000 tons at the present time. With all these developments Murray Morrison was closely connected and largely responsible.

He did much, too, for the increase in the production of alumina from the ore bauxite. The original alumina factory at Larne, in Northern Ireland, soon was too small for the company's ever-growing needs, and Morrison who had been appointed general manager in 1910, and managing director in 1927, planned and built new alumina factories at Burntisland in Fife, in 1918, and later the Newport, Monmouthshire, works in 1938. On the rolling and fabricating sides of the industry he developed the rolling mills set up at Milton in Staffordshire, at Warrington in Lancashire, and the great plant started at Falkirk during the recent war. He thus created the chain of alumina factories, the Highland reduction plants and the factories and mills for working the metal, and so firmly established the aluminium industry in Great Britain.

He was made deputy chairman of the British Aluminium Company, Ltd., in 1934, and he was managing director of The British Aluminium Company, the North British Aluminium Company, and the Lochaber Power Company from 1930 until 1945, when he retired.

In addition to home developments Sir Murray established reduction or fabricating plants in Norway and in India, and in association with other interests, in Australia and in China. Bauxite mines were established in France, British Guiana and on the Gold Coast. In this international work he achieved a high reputation for his technical and business acumen and his many friends and associates saw his skill in negotiation, his clarity of judgment and his foresight with admiration. He made many friends and gathered around him a loyal band of collaborators, to whom he gave every encouragement and help.

He was a valued member of the Institution of Civil Engineers and a member of the Institution of Electrical Engineers, having served on the Council. He was a Fellow of the Institute of Physics and a Past President of the Faraday Society and the Institute of Metals. In 1942 he received the Institute's Platinum Medal, and Fellowship. He was also a vice-chairman of the British Non-Ferrous Metals Association.

In 1933 Sir Murray was made a Commander of the Order of St. Olav of Norway, and in 1943 he was knighted by the King for his services to this country. During two wars he was one of the Government's principal

advisers on the production of aluminium and its uses for war purposes. In spite of his keen interest in his work, he found time for other activities and took a keen interest in the development of the Highlands. Among his many friends Sir Murray Morrison will long be remembered by his charm of personality, and the great work he undoubtedly accomplished.

SIDNEY SMITH

On Sunday, May 30th, the death occurred at his home, "Gunyah," The Knoll, St. Kilda Road, Orpington, Kent, on his sixty-fifth birthday, of Mr. Sidney Smith, the managing director of the Wellman Smith Owen Engineering Corporation, Ltd. Mr. Smith, we may recall, succeeded his brother, the late Mr. James Foster Smith, as managing director in February, 1947. He had been associated with the Corporation since its founding in 1922.

Sidney Smith was born at Hitchin, in Hertfordshire, and received his early education at Harpenden. He was apprenticed to Robey and Co., Ltd., of Lincoln, in 1898, and for seven years he gained practical experience in all the departments of the firm, staying on in the drawing office for an extra year. During those years he pursued his technical training at evening classes at the Lincoln Technical College.

In 1906 he was appointed to the crane department of Babcock and Wilcox, Ltd., in London, and he stayed with that company until 1908. In that year he joined the firm of Wellman Seaver and Head in London, serving as leading draughtsman and taking part in outside erection work.

The next three years Mr. Smith spent in Canada, where he gained new experience in manufacturing, contracting work, and administration duties, with the Jeffrey Manufacturing Company of Montreal; Mussens, Ltd., of Montreal, and the Jenckes Machine Company, of Sherbrooke, Quebec Province.

In 1914 he returned to this country, and was appointed engineer to the Whitehead Iron and Steel Company for its proposed extensions, and was later made engineer-in-charge of the Briton Ferry Steel Works in South Wales, a position he continued to hold until he joined the then newly formed Wellman Smith Owen Engineering Corporation, Ltd., in 1922. For a short time he was given charge of the company's pulverised fuel machinery section, and was then made responsible for the management and development of the seamless steel-tube machinery section. Mr. Smith, it can be said, was largely responsible for the great advance made in the production of steel tube by the push-bench process development work, in which he collaborated closely with the engineers of Stewarts and Lloyds, Ltd. The perfecting of that process was so complete and final that it was possible not only to equip the leading British steelworks with the latest machinery, but for some years to supply such machinery to countries abroad, including Canada and the United States of America. During the last war, the push-bench process evolved for the manufacture of seamless steel tubes formed the basic principle from which the machinery was designed for the mass production of shells.

Mr. Smith was a member of the Institution of Mechanical Engineers and of the Iron and Steel Institute.

For a time he acted as chief engineer to the Wellman Smith Owen Engineering Corporation, Ltd., and he succeeded his brother as its managing director in 1947. He had a kindly disposition, and he endeared himself alike to his colleagues and his friends.

Sidney Smith will perhaps best be remembered as an able engineer who did much to improve the design of machinery equipment for British steelworks.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

THE CROWSNEST LINE, C.P.R.

Sir,—Mr. Livesay's letter is certainly interesting, though at the same time leaves matters much as they were because it still seems that the fundamental principles governing the tractive force of steam locomotives are by no means clear to your correspondent. The observations made in the final paragraph would appear to support this conclusion.

Perhaps I may be pardoned if I just remark that, other related factors being equal, the tractive force developed is proportional to the working volumes of the cylinders. From this it follows that an engine having cylinders with a 24in stroke might be expected to work over the Crowsnest line equally as well as one having a 32in stroke.

E. C. Poultney.

London, N.W.3, May 28, 1948.

INSTITUTIONS AND THEIR MEMBERS

Sir,—The recent Special Meeting of the Institution of Mechanical Engineers has shown both by the correspondence and leading articles which have appeared in the Press how essential it is that by-laws be interpreted strictly, but these same by-laws are quite silent as to the length and nature of the minutes of a meeting.

Whatever may be the merits of that which takes place at any meeting, it is highly desirable that the minutes as read should contain all the essential facts, without, however, going to the length of being a verbatim report. The object of minutes is surely to place on record that which actually transpired, and the submission of the minutes to the members is to confirm their accuracy. This object can possibly fall short of attainment if, as occurred not long ago, abstract minutes were read, and at the same time it was stated that a verbatim report of the meeting was attached to the minutes but not read. This verbatim report might easily contain some error which would be patent to the members if read, yet would escape notice at a later date should it be necessary to refer to the verbatim report when memories had been dulled by time.

At the Special General Meeting referred to, both from actual observation together with the reports that appeared in the Press, the following did in fact occur.

(1) The chairman on his own responsibility put the resolution to the vote without first ascertaining if there were members present who still wished to speak, or any member having moved that the resolution be put, and the meeting having passed this resolution first.

(2) Several members did in fact desire to speak but were prevented from doing so by the chairman.

(3) The chairman called for a show of hands but took no steps to ascertain if the motion was carried or not.

(4) The chairman made no declaration as to whether the motion was or was not carried.

I write this letter now as I understand that the Summer Meeting of the Institution of Mechanical Engineers, which is to be held in Glasgow, ranks as a General Meeting of the Institution and that therefore the minutes of the last Special Meeting are due to be presented there for confirmation and it is, of course, probable that but few of the members who were present at the meeting in London will be present also at the Glasgow meeting. It is therefore all the more essential that those who are present when the minutes are to be presented for confirmation should be acutely aware or make themselves aware of that which actually transpired in London.

R. J. Low.

Staines, May 30, 1948.

THE BRITISH INSTITUTE OF MANAGEMENT

Sir,—The endowment of this newly created body is a unique feature in the history of institutions. The sum of £150,000 to be spread over five years, granted by the State, will enable it to get on its feet quickly, avoiding that slow development which has characterised all professional bodies in the past. It starts with a council of twenty-eight eminent members, including representatives of the Federation of British Industries, of the Civil Service and of the trades unions. Experience has dictated this widely cast net. It bridges a gap between trades and professions and establishes continuity between them. The titles of learned professions has gone, has, indeed, been steadily vanishing for some time. Just as there are now no distinctions to be made between race or sex or religion in viewing the world from the moral standpoint, so there are none to be made between the different industries. Every man or woman fulfilling a necessary duty is to be regarded as a cog in the wheel of life.

"Two men I honour and no third," said Carlyle in "Sartor Resartus." "First the toil-worn Craftsman that with earth-made implement laboriously conquers the earth and makes her man's. Venerable to me is the hard hand, crooked, coarse, wherein notwithstanding lies a cunning virtue, indefeasibly royal as of the sceptre of the planet. . . . A second man I honour and still more highly, Him who is seen toiling for the spiritually indispensable, not daily bread, but the Bread of life. . . . These two in all their degrees, I honour. All else is chaff and dust, which let the wind blow whither it listeth."

A. W. Crampton, F.R.I.C.S.

London, N.W.6, May 24th.

BOOKS RECEIVED

Textbook of the Materials of Engineering. By Herbert F. Moore. Seventh edition. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 30s.

Engineering Applications of Fluid Mechanics. By J. C. Hunsaker and B. G. Rightmire. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 30s.

Handbook to the Factories Act and Truck Acts. By Joseph Owner. Third edition. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, W.C.2. Price 7s. 6d.

Theory of Servomechanics. By Hubert M. James, Nathaniel B. Nichols and Ralph S. Phillips. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 5 dollars.

Locomotive Management. By Jas. T. Hodgson and Chas. S. Lake. Ninth edition. London: St. Margaret's Technical Press, Ltd., 33, Tothill Street, Westminster, S.W.1. Price 10s.

Instrument and Control Manual for Operating Engineers. By Eugene W. F. Feller. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 6 dollars.

Elements of Nomography. By Raymond D. Douglass and Douglas P. Adams. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 3·50 dollars.

Manual of Practical Office Short Cuts. Compiled by National Office Management Association. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 21s.

British Standard Specifications for Gearing

By W. A. TUPLIN, D.Sc., M.I.Mech.E.*

THE benefits of standardisation bless both him who gives and him who receives.

A British Standard Specification is not an arbitrary list of figures drawn up by some individual to whom the job has been delegated, but is the result of discussion between representatives of every organisation that has any considerable knowledge of the subject concerned. The interchange of opinions and varied experiences sometimes suggests a need for complete revision of ideas and causes them to be presented, perhaps for the first time, on a logical basis. Thus, those who spend time and labour in contributing to the production of British Standard Specifications and so giving the benefits of their experience to engineers in general, do secure some advantages themselves.

The British Standard Specifications 436, 545 and 721 on gearing have produced these effects in a marked degree, and there can be few specifications in which definitions and formulæ have been devised, discussed and revised with such relentless persistence. The different meanings commonly attached to the term "pitch diameter," for example, require special care in devising a definition that excludes undesired meanings and the difficulty in defining accurately and concisely what is meant by a "right hand helix" can be appreciated only after actual trial.

Standardisation of the symbols to be applied to the dimensions of a gear (*e.g.*, normal pitch, axial pitch, &c.) was, in the main, easy, as one reasonably logical scheme was already in existence. An entirely different scheme has gained some approval in America and the question has been raised as to whether a common system should be agreed upon for Great Britain and U.S.A.

It might be thought that all problems in gear geometry have long since been solved and whilst that is probably the case, the solutions are not always easy to find. The kinematics and geometry of gears have attracted the attention of enthusiastic specialists for a hundred years or more and every question one can ask in this field has been answered long ago by somebody somewhere. It is, in fact, open to anyone sufficiently interested and industrious to compile a comprehensive book with every appearance of authority from a carefully edited assembly of published work twenty-five or more years old. Nevertheless, with all this knowledge at command, there have been uncertainties, chiefly in connection with load capacity, on points that can be checked only by special and rather prolonged tests. The variation of load capacity with change in helix angle is an example of a matter on which careful study revised an earlier and inadequately-checked estimate.

A long-accepted formula for load capacity of gears is that due to Lewis, but as its criterion is bending stress, with no consideration for surface stress, it was clearly irrational in view of the fact that comparatively few gear failures are caused by fracture of the teeth. Well back in the nineteenth century Hertz had investigated mathematically the stresses induced in elastic materials by loaded contact of their surfaces but it was not until later that practical tests were made to secure basic data on the behaviour of metals subject to lubricated sliding and rolling contact such as occurs in gear teeth.

The British Standard formulæ for load capacity of gears are largely empirical. They were developed on the fairly obvious basis of Hertzian contact stresses so far as "wear" is concerned, and the equally obvious simple cantilever theory (as used by Lewis) was used to determine bending stresses. The more difficult problem of estimating the actual tooth load from the nominal one corresponding to the mean transmitted torque was sidestepped—as it had to be in devising a formula for general application—by adjusting arbitrary constants in the skeleton formulæ so that they gave results that lined up with actual practice over a wide range of duties. To do this, the extensive records of several of the leading British gear manufacturers were used and the labour of a number of members of their staffs was employed in the operation of repeated trial. The procedure was not highly scientific, but it produced a useful result, whereas a rigorous approach would lead to a result too complex to be of any practical value, if any strict analysis could be developed at all.

The British Standard formulæ thus take automatically into account the average effects of imperfections in gear manufacture, mounting and lubrication and of inertia and elasticity in the gears and the associated rotating parts. It has always been known that the margin necessary to accommodate such variables inevitably meant, on the one hand, the specification of nominal stresses much lower than gears could actually take, and on the other, that specific applications of gears may produce tooth loadings much higher than would normally be associated with the nominal loading. Consequently, it ought not to be surprising that when gears have to be reduced to the minimum possible dimensions, as for example in aircraft practice, variations in details of the running conditions may raise actual loading of the teeth to the failure point. The fact is that if the utmost is to be achieved in reduction of dimensions, the conditions that determine actual tooth loading must be examined in far greater detail than is necessary in less stringent circumstances.

It is interesting to note, however, that whilst the gear designer who seeks the very minimum dimensions must thus face the necessity of using a "formula" much more complicated than any suggested in British Standard Specifications, there are frequent requests from designers of industrial gears for much simpler formulæ than the British Standard ones. It is, of course, always possible to simplify a formula at the expense of accuracy just as it may often be made more accurate by complication, but the present British Standard methods of assessing load capacity are thought to represent a reasonable compromise, and a little practice in using them robs them of any apparent difficulty.

It is natural to think that as the B. S. specifications on gearing have been devised to cover the whole wide range of gearing applications, simplified methods might be used with adequate accuracy in limited spheres. For example, all lift gearing falls within relatively narrow limits of size and, by reason of its intermittency of operation, is somewhat specialised. It has been suggested that modified formulæ adequate for the range of lift gears might be derived from B. S. formulæ, but it is doubtful whether the loss in accuracy would be justified by the small economy in time relatively to the by no means laborious standard methods. Whilst it is open to any gear designer to adapt the B. S. formulæ to his own particular needs, it would obviously be cumbersome, to say the least, if a Standard Specification were to be expanded to include all such adaptations. Furthermore, such a course would be opposed to the whole principle of standardisation and would tend to obscure the fundamental similarities of all types of gear.

A safeguard against any tendency to specialisation in the gearing specifications is the broadly representative constitution of the committee. Every person and organisation that can reasonably claim expert knowledge of any branch of gearing technology is either on the committee or is represented on it. There are so many different contributors to the results produced by the committee and such thorough criticism of everything before acceptance that the specifications are the mean of a number of authoritative opinions and represent a truly co-operative effort. Certain it is that nothing in a British Standard Specification on gearing can be claimed as the work of any individual.

The secretary of each sub-committee of the British Standards Institution is an official of the Institution and performs the same duty on several other sub-committees. Despite the consequent spread of interest, it frequently happens that the secretary shows himself to have a sounder grasp of the immediate work of the committee than do its members, who are specialists in the subject. This has often called forth appreciative comment and is yet another demonstration that one who is to some extent an onlooker may secure the broadest view of what goes on.

* Head of Engineering Research and Development, David Brown and Sons, Ltd., Huddersfield.

U.S. Sewage Treatment Costs

RESEARCH at the Harvard Graduate School of Engineering has indicated that by substituting oxygen for air in biological-sludge processes, the size of newly designed sewage treatment plants can be reduced to about one quarter of the present sizes. Development of the new process, which has been termed "bioprecipitation," was suggested by Malcolm Pirnie, Past-President of the American Society of Civil Engineers, and the experiments at Harvard were conducted by Daniel A. Okun, of the teaching staff. As sewage saturated with air contains only about 9 p.p.m. of dissolved oxygen and sewage saturated with oxygen will contain 45 p.p.m., it is estimated that the bioprecipitation process can be loaded per unit of tank volume about four times more heavily than a conventional activated-sludge process to achieve about the same results. That is, for the same quality of sewage treated, about one quarter of the plant is required.

The research results by Mr. Okun indicate that oxygen requirements are satisfied at all points in the plant flow by preoxygenating the sewage to be treated; use of pure oxygen promotes efficient gas transfer and the penetration into the floc particles is deeper; separate final sedimentation facilities are not required, and because of more "sympathic" treatment of the biological floc, it is expected that better purification of sewage will result. From the operational results of a proposed pilot plant, which is to be constructed in the near future, a more precise assessment will be made of the values and advantages of the newly developed bioprecipitation process of sanitary sewage treatment.

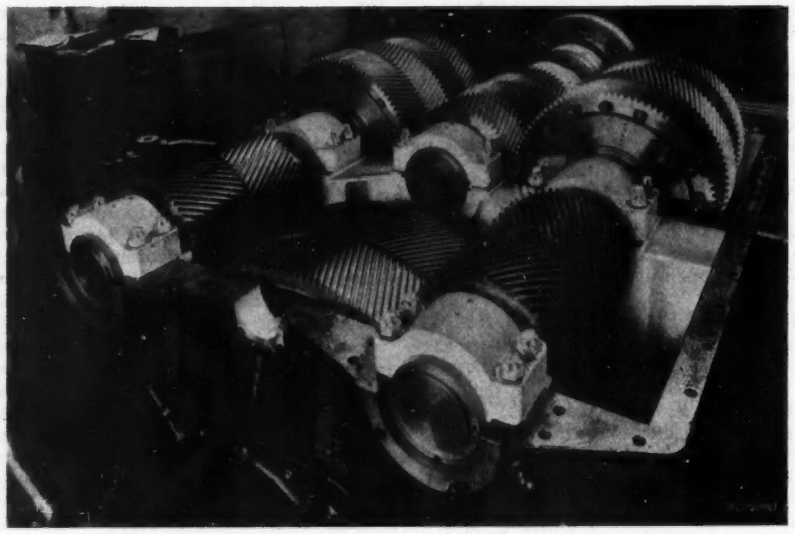
2000 S.H.P. Marine Reverse Reduction Gear

WE recently visited the works of Modern Wheel Drive, Ltd., at Slough, to witness the shop test of a large S.L.M. oil-operated marine reverse and reduction gear, which has been designed and built by the company for the motor collier "Catford" of the South Metropolitan Gas Company, now under construction at the yard of S. P. Austin and Son, Ltd., of Sunderland. The gear, which we understand is the largest yet of its particular kind, has been designed to transmit a total power of 2000 s.h.p. at an input shaft speed of 450 r.p.m., but for the service for which the installation is intended the following contions have been specified :—

Continuous rating	1425 h.p. at 423 r.p.m.
Six-hour rating	1585 h.p. at 440 r.p.m.
Total reduction ratio	5·42 ahead 5·28 astern
Michell thrust bearing	For 30-ton propeller thrust
Type of engine	Ruston and Hornsby 6-cyl. VOXM
Net approximate gear weight	10 tons

From the accompanying illustrations it will be seen that the gear is of robust self-contained construction. It is coupled to the engine through a Bibby coupling. The gear primary shaft is furnished with an ahead and astern pinion, the ahead pinion meshing directly with the ahead gears on the two clutch shafts, while the astern pinion meshes, through an idler, with the astern gear also mounted on the clutch shaft. Each of the two clutch shafts is, at its aft end, provided with a final pinion, which mesh with the gear wheel on the output shaft. Double helical gearing is used throughout the whole transmission, and it is claimed that the flexibility inherent in the oil-operated clutches overcomes the disadvantages of an otherwise locked gear train. Plain bearings, pressure lubricated, position the four shafts in the gear casing, and on the output shaft there is fitted a Michell type of thrust bearing, the housing of which is integral with the main gear casing.

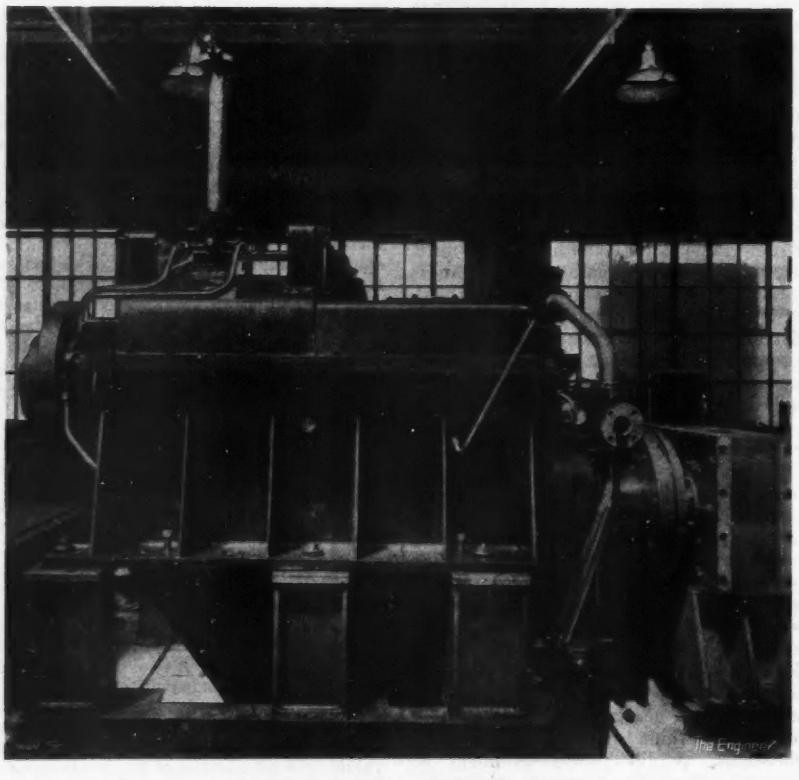
The gear is constructed in such a way that by lifting the top cover, as shown herewith, all the working parts become accessible. It is designed so that it can be run either as a wet or a dry sump unit. When running with a wet sump gearbox, the arrangement adopted is as follows :—The two pressure oil pumps directly driven from the primary side of the gear draw the oil from the sump, deliver it at 70 lb per square inch through an "AutoKlean" filter, and a Serck tubular oil cooler to the pressure-regulating and overflow valve, thence to the control cock unit and the respective distributors of the oil-operated clutches. When running as a dry sump box two auxiliary motor-driven oil pumps are connected to the pressure oil pipe system of the gear with the necessary stop and non-return valves. One of these auxiliary oil pumps acts as a pressure pump drawing the oil from an overhead tank and delivering it to the oil pressure relief valve, &c., on the gearbox. The second auxiliary pump, which is of slightly larger capacity, draws the oil from the gearbox sump and delivers it through the filter and cooler to the overhead tank



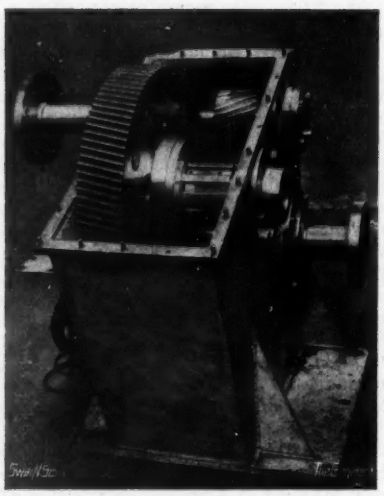
GEAR CASING WITH TOP COVER REMOVED

The two oil systems are interconnected in a suitable manner, so that the change-over from wet to dry sump or *vice versa* is a matter of a few minutes. If the electrically driven auxiliary pumps are used, the other two pumps are arranged to idle. The arrangement described ensures that a set of stand-by oil pumps is always available, should trouble occur in any of the pumps.

A noteworthy feature which we tested for ourselves is the means and ease of control with which reversing can be effected. Very little effort is required on the approximately 6in long operating handle, which was used on the gear for test to change over from one direction of rotation to the other and it was demonstrated that this change-over could be effected within a matter of a few seconds



REVERSE REDUCTION GEAR ON TEST



CLUTCH TESTING RIG

although this is not advised aboard ship. In the ship the gear control is interconnected with the engine governor so that as soon as the gear lever is moved from ahead to astern or *vice versa*, the engine speed is automatically reduced, the actual reversal of the propeller and shafting being effected at engine idling speed.

Test Bed Arrangements

The gear was coupled to a 550 h.p. variable-speed a.c. motor by means of a speed-reducing gear, giving a motor speed of 1250 r.p.m. and a gear input shaft speed of 423 r.p.m. At this speed, the gear output shaft runs at 80 r.p.m., and the shaft was connected by means of a speed-increasing gear to a Heenan and Froude dynamometer. The actual brake load on the dynamometer was only 100 h.p., a larger dynamometer not being available. Preceding this shop test of the assembled unit the makers had carried out individual clutch tests with a special box by means of which each clutch was subjected to a full-load power test for some two hours' duration. The tests showed that the oil-operated clutches have an ample margin of safety, since their maximum torque-carrying capacity is some 45 per cent above the full-load torque which they will be called upon to transmit under actual service conditions.

In general, the gear appeared to be of strong and sound design, and it appears to be well suited for the duty for which it will be called upon to perform. During the test run oil temperatures, we noted, were low and did not exceed 110 deg. to 120 deg. Fah.

Large Gears for Marine Duties

In view of the interest now being taken in large power gears for steam turbine and gas turbine propelling installations, we were interested to examine new designs prepared by the firm for these specialised duties. One of these units was a marine gear unit, incorporating oil-operated clutches for ahead and astern running and arranged for a steam turbine drive of 24,000 h.p. at 6000 r.p.m., with a reduction ratio of 17·2 : 1. In this arrangement reversing is a function of the gear only. Another gear unit as above was for a gas turbine drive at 12,000 r.p.m. on the input shaft, with a reduction ratio of 34·3 : 1. Again in this design, reversing is a function of the gear. A further gear unit, incorporating ahead and astern running, was for coupling to a 15,000 h.p. turbine at 3000 r.p.m., with a reduction ratio of 12 : 1. Of special interest was a twin-engine reverse-reduction gear which is actually on order for twin 1400 h.p. engines at 300 r.p.m. on the input shafts, and a speed of 165 r.p.m. on the output shaft. In this gear provision is made to isolate each engine at will, and also to start up one engine from the other by engaging the respective oil-operated clutches.

Gas Carburising Equipment

THE use of gaseous media for the carburisation of steel has many advantages, particularly where large components requiring relatively deep cases have to be treated, and precise control is of importance. Where natural gas, such as that obtainable in America, is not available the carburising atmospheres used are normally of the high hydro-carbon type suitably diluted. Typical examples of such atmospheres are butane or propane diluted with charcoal burner gas, raw town gas or burnt town gas. Unfortunately, such hydro-carbons possess the characteristic of "cracking" on the steel surfaces at temperature and result in "sooting" or carbon deposition. These depositions of soot on the work slow the rate of carburisation and it is not possible to maintain the precise control conditions necessary for uniformity and consistency of the case.

A process has now been introduced by Wild Barfield Electric Furnaces, Ltd., of Watford, Herts, for the conditioning of town gas for steel carburising purposes. It is claimed for this process that raw gas from the mains is prepared for carburisation without additions such as butane, propane, &c., and all deleterious constituents likely to give rise to sooting are removed. The company has sent us the following typical analysis of a town gas before and after passing through the conditioning equipment.

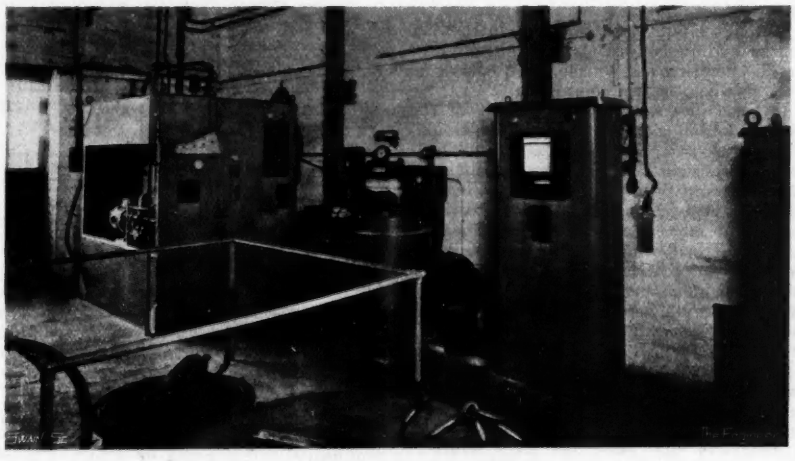
	Raw town gas, per cent	Prepared town gas, per cent
Carbon dioxide	3·3	—
Oxygen	0·6	—
Unsaturated hydro-carbons ...	2·1	0·6
Carbon monoxide	16·4	20·2
Methane	24·0	23·6
Hydrogen	49·5	51·2
Nitrogen (balance)	4·1	4·4
	100·0	100·0

It will be seen that the methane content is only slightly reduced and there is a considerable increase in the amount of carbon monoxide. Town gas supplies vary according to the method of production, but invariably if the methane content is low, the carbon monoxide content is correspondingly high.

The process makes use of a catalyst and in the equipment raw gas from the mains is driven through a flow-meter into a catalyst chamber for conditioning. The conditioned gas emerging from the catalyst chamber is passed through a cooler, silica gel drying chambers and thence via an inferential meter to the carburising retorts. Duplicate dryers are fitted so that the plant can continue in service with one, whilst the silica gel in the other is being regenerated in a small forced air circulation furnace. The catalyst and dryers are regenerated after a certain volume of gas has passed through them for purification, the total volume being read on the inferential meter. The frequency of regeneration is dependent upon the volume of gas passed, but normally does not exceed once per week. Regeneration of the catalyst can be conveniently carried out while a charge is being diffused and the preparation unit is not required. We understand that standard equipment is available for gas flows up to 200 cubic feet per hour.

In operation the retort is purged and lowered into the furnace controlling at the specified carburising temperature, and after adjustment of the gas flow by means of the flow-meter, no further attention is required until the "active" carburising period is finished. The compressor is then stopped and the inlet and outlet valves of the retort closed. The preparation unit can then be used to purge other retorts while the first charge is completing the diffusion period. The photograph we reproduce shows a gas preparation unit in the background, with the top of the retort and carburising furnace door visible in the foreground.

It is claimed by the makers that the use of prepared town gas allows precise control of the depth and type of case on components. No hard carbon is deposited, the only deposit being in the form of powdered graphite, which has no damaging effect. There is no necessity to achieve any balance of mixture to minimise sooting, and carburising can proceed at the correct temperature for the steel under treatment. Furthermore, precise control over diffusion enables the "active" carburising to be undertaken at the maximum theoretical rate.



Gas Preparation Plant

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1.

EARTHING CLAMPS

No. 951. This Standard, originally issued in 1938, has now been revised as a result of extensive work by the British Electrical and Allied Industries Research Association, which has recommended the use of a certain design of clip and clamp, details of which are given in the revised standard. The clamps referred to in this standard are intended for connecting earthing leads and earth continuity conductors of electrical installations to metal pipes of a nominal internal diameter up to 3in (corresponding to external diameter up to 3¼in) and also to sheaths of lead-covered cables. The material to be used in the construction of the clamp was not specified in the original edition, and this has now been included in the revised edition. Price 2s. 6d., post free.

30-A FLAMEPROOF PLUGS AND SOCKETS AND CABLE COUPLERS

No. 1395. This Standard has been prepared to meet the demand for a lighter-duty standard flameproof plug and socket than that provided for in B.S. 279, "100-A Flameproof Plugs and Sockets." It provides for plugs and sockets which are flameproof in accordance with B.S. 229. Two types of plugs and sockets and cable coupler are covered by this specification, the restrained type which is for use with electrical interlock and the bolted type which is for use with or without electrical interlock. The specification prescribes the dimensions necessary to ensure interchangeability of complete plugs in complete sockets of different makes, and deals with some electrical and mechanical requirements. It does not otherwise specify a fully detailed design. Price 3s. 6d. post free.

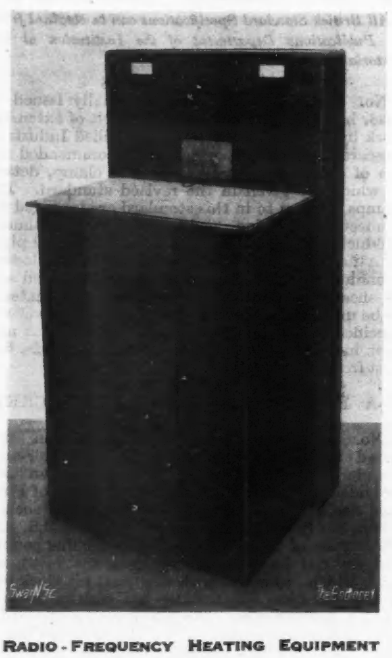
The British Road Federation.—The British Road Federation has lately published its annual report for 1947. In a survey of its activities during the year, the Federation expresses the view that all preliminary work on major road development should be continued and the acquisition of the necessary land should go on, since the time taken to acquire the land is often longer than is actually taken to build the road. The importance of road communications to the economic recovery of the country is, the report says, not fully realised by the general public, and the Federation proposes to press forward its programme of education in order to bring home to the nation the importance of an adequately maintained highway system.

Radio-Frequency Heating Equipment

We have received some details of a recently introduced radio-frequency heating equipment which has a continuously rated output of 2·5kW at the terminals. This unit (model F5) extends the range of radio-frequency heating equipment manufactured by Philips Electrical, Ltd., Century House, Shaftesbury Avenue, London, W.C.2, so as to cover the application of this form of heating to small jobs, such as soft and hard soldering, "spot" heating and local hardening of small components.

The generator has been designed for flexibility, and easy adaptation to the job. A six-position matching control switch on the left of the instrument panel, as illustrated herewith, adjusts the generator to the work, making it possible to obtain full power in a wide range of jobs without any laborious work coil design. An on-load continuously variable power control brought out to a knob and scale on the right hand of the front panel is also provided, giving smooth control of power from almost zero to maximum. These two features make the generator particularly suitable for production work where small batches of jobs of different kinds have to be treated, as well as for experimental work. Two meters on the front panel indicate valve input current, and generator output current. The other controls on the front panel are an "H-L" power switch, and the generator "on-off" switch. The radio-frequency power is controlled by a foot switch, attached to a length of cable.

As shown in our illustration this set incorporates a built-in work table. The table top, of Sindanyo (asbestos sheet), is mounted 42in above the ground and immediately below the output terminals. For certain applications, such as conveyor belt production work, this



RADIO-FREQUENCY HEATING EQUIPMENT

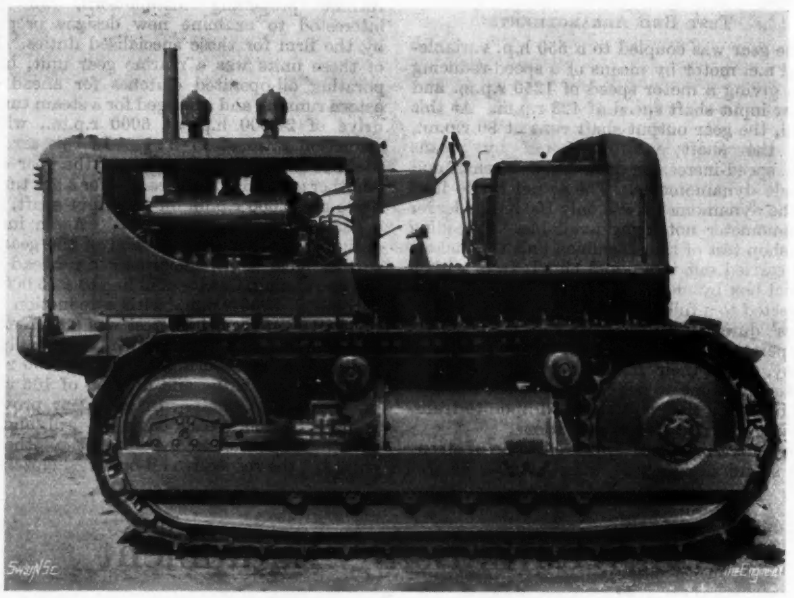
arrangement of work table would not be suitable and, accordingly, provision is made for alternative outlet terminals at the side of the generator.

Servicing is made easy by arranging the lay-out so that all components of the generator are accessible when the two panels are removed. Safety interlocks are included so that the action of removing either panel makes the set "dead." All circuits and components are protected by H.R.C. fuses, with a hand reset overload trip to prevent misuse of the set.

The power consumption of the F5 equipment is 5kVA at 0·85 power factor, and it is suitable for operation from single-phase a.c. mains at 200V to 250V. The overall dimensions are 60in high, 33in wide and 28½in deep, and the unit is mounted on castors for ease of movement.

A Large Industrial Tractor

We illustrate herewith the new H.D.19 model Allis-Chalmers tracklaying tractor, said to be the largest tractor of its type ever built. This tractor weighs about 40,000 lb and, taking the maximum drawbar pull at 90 per cent of its weight, it is capable of exerting a 36,000 lb pull in low or reverse gears. Extra equipment, such as a bulldozer or tree-stumper, will, of course, increase the adhesion and will confer a proportionate increase in draw-bar pull. Ground pressure is 7·8 lb per square inch of track contact.



H.D.19 INDUSTRIAL TRACTOR

It is interesting to note that this vehicle has been designed to combine a three-stage hydraulic torque converter with a two-speed and reverse gear-box, giving forward speeds up to 7 m.p.h. and reverse speeds up to 5½ m.p.h. The engine is a General Motors 6–71 two-stroke, six-cylinder diesel, with a designed maximum power of 163 b.h.p. at 1750 r.p.m. Steering clutches are operated hydraulically, thus reducing physical effort in operating the vehicle. Self-energising brakes also help in this connection.

The basic design is similar to that of the H.D.5 model but maintenance has been simplified by wick-feed lubrication and 1000-hour lubrication periods for the bogie wheels, support rollers and front idlers, all of which are fitted with seals and tapered roller bearings. There are no lubrication points under the tractor, as the oscillating bearings of the bogie frames are automatically lubricated from the final drive compartment. The simplified construction permits separate and independent removal of steering clutches, final drive pinions, gear-box, together with gear clusters, and the bevel gear pinion.

Distributors for Allis-Chalmers Industrial Tractors in this country are Mackay Industrial Equipment Company, Ltd., of Feltham, Middlesex.

Magnetic Fluid Clutch

A new type of electromagnetic clutch, developed by Mr. J. Rabinow, chief of the ordnance mechanics' laboratory, U.S. National Bureau of Standards, is described and illustrated in a recent issue of the Bureau's *Technical Bulletin*. The development of this clutch arose from the mechanical part of the work done by the Bureau on the electronic computers now under construction there.

The clutch depends for its operation on the control, by the application of magnetic fields, of frictional forces between the surfaces of solids and certain fluids. When the space between two parallel magnetic surfaces is filled with finely divided magnetic particles and a magnetic field is established between the two plates, the particles are mutually attracted, bind together in the field, and the mixture "solidifies." As the magnetic field can be produced by an electric current, a simple means of control is possible. The magnetic particles may be finely divided iron mixed with a liquid, such as oil, to prevent packing and to smooth the operation of the clutch. It is said that any degree of slipping or complete locking can be obtained by suitably controlling the magnetic flux. An accompanying diagram shows one arrangement, in which current is fed through slip rings to a coil mounted between the outer driven clutch plates.

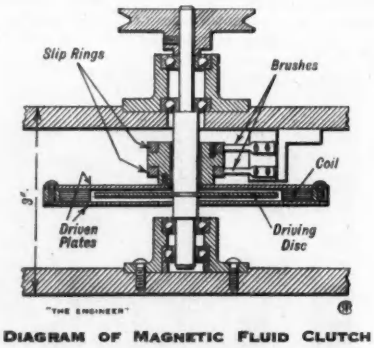


DIAGRAM OF MAGNETIC FLUID CLUTCH

Modern Applications of Liquid Fuels.—A conference on "The Modern Applications of Liquid Fuels," which is being arranged jointly by the Institute of Petroleum and the Institute of Fuel, is to be held at Birmingham University on September 21st, 22nd and 23rd. The papers to be presented will deal with the use of oil fuel in the iron, steel and non-ferrous metals industries, in glass-making and the ceramics industry, and in agriculture. Other contributions will discuss the combustion problems of the gas turbine, the use of gas oil in gas manufacture, liquid fuels for domestic heating, and diesel engine fuels. Mr. J. A. Oriel will act as president of the conference and will deliver an address on "The Place of Liquid Fuel in the British Economy," at the opening session, on September 21st. The general secretary of the conference is Mr. R. W. Reynolds-Davies, Institute of Fuel, 18, Devonshire Street, London, W.1.

Continental Engineering News

The Rotterdam Botlek Plan

The capacity of the port of Rotterdam, now estimated at 30 million tons, is considerably in excess of the country's own requirements. Before the outbreak of hostilities three-quarters of the goods traffic via Rotterdam represented transit trade to and from Western Germany.

This trade current has, however, greatly decreased since the war's end. In order to prevent partial unemployment of the port in future, the municipality of Rotterdam has prepared a comprehensive scheme, destined to make available for industrial undertakings a site of 2000 acres situated along the south bank of the River Meuse, halfway to the Hook of Holland. The plan is called the Botlek plan, after the river branch crossing this area. A site of 480 acres, situated in the Spanish Polder north-west of the city, has already been chosen for the establishment of industries, including those which were destroyed by air bombing in 1940.

The subsoil of the new industrial area being of good bearing value, no special trouble is expected as regards foundation work of industrial plants.

The Botlek district will be linked by rail and road with the harbour and the residential quarters of Rotterdam. This will involve the construction of a highway bridge and a railway bridge over the Old Meuse. As the new district is about 7 miles from the city of Rotterdam South, houses for workers will have to be built in the vicinity of industrial plants.

The Botlek plan contemplates the building of a centre of approximately 60,000 inhabitants, based on the principle of the " satellite " town.

Industrial Exhibitions in Belgium

The twenty-second Brussels International Fair was held from April 17th to April 28th. The stands were situated in several of the palaces at Heysel, built for the World's Exhibition in 1935, and covered an area of 850,000 square feet. Exhibits were shown by some 3700 firms in the following industries :—Machine tools, electrical and mechanical engineering, ironmongery, structural engineering, furniture, heating appliances, wireless, clock manufacture, textiles, &c. Thirty nations were represented. The first Belgian Shipbuilding Exhibition was held in the Palais des Beaux Arts, Brussels, from April 24th to May 7th. The exhibition was divided into several sections, including sea-going vessels, river boats, colonial shipping, furniture, naval engines, organisation of shipyards and welding technique in shipbuilding. At present, 122 Belgian firms deal with either shipbuilding or ship repair work. In 1947, orders to Belgian shipyards amounted to some 3000 million B francs (£17 million), of which about 70 per cent were reserved for export.

Spanish Railway Centenary

Spanish railways are celebrating this year their centenary. The first Spanish railway line, 15 miles long, linking Barcelona with Mataro, was opened on October 28, 1848. At the time of its opening the rolling stock of the line was composed of four 40 h.p. locomotives, ten first-class coaches, twenty second-class coaches, thirty third-class coaches and thirty goods wagons. The line crossed rivers over several bridges, of which the bridge over the River Besos was 1200ft long and the bridge over the River Argentona 800ft. In addition there was a tunnel, 500ft long. The cost of the line was 20 million Reales (about 5 million pesetas, or £115,000).

At present the overall length of the Spanish railway network amounts to some 10,000 miles, of which 75 per cent are normal Spanish gauge (5½ft) and 25 per cent narrow gauge. Numerous bridges, some of them representing real engineering feats, carry the lines over rivers and deep ravines. The most notable Spanish railway bridge is the Esla viaduct, a concrete structure with a central arch, having a 672ft span and a 142ft rise. Electrification of lines is progressing satisfactorily (although slowly), and it is hoped that by 1959 40 per cent of lines will be electrified. Works for the electrification of the 100-years-old Barcelona-Mataro line are now in good progress.

The Senne Canal, Brussels

Some areas of the city of Brussels are crossed by the River Senne. With the object of draining flood water, concrete culverts have already been constructed on some sections of the river. At present, important works are being carried out for the diversion of the River Senne, in close connection with other works, for a new dock in the harbour of Vilvorde, a suburb of the Belgian capital. Waters of the River Senne will flow through a concrete canal and the old bed of the river will be filled with earth coming from the dock excavation.

The canal, 11ft deep, will consist of two channels, each 17ft wide, one of which can be cleaned whilst the other is utilised for water discharge. Side walls of the canal, for whose construction steel sheet piling was used, are 16in thick ; the vault resting on these walls is 20in thick. The overall length of the canal will be about 3½ miles, of which a portion was completed before the Second World War. It is estimated that the whole scheme will be completed within ten years.

Canadian Engineering Notes

Welded Elevated Tank

The first all-welded, elevated municipal water tank to be erected in Canada was completed recently in Sillery, a residential suburb of Quebec City. An interesting point is the use of tubular supporting columns approximately 100ft high without any lateral support. The tank has a capacity of 300,000 gallons and the height from ground level to the bottom of the tank is 85ft. The new tank was fabricated at the plant of Horton Steel Works, Ltd., in Fort Erie, Ontario, and was erected at Sillery under the direction of H. W. McLeod, of the company's erection staff. The structure has an ellipsoidal bottom and roof, the depth of the bottom being one-third and the depth of the roof one-quarter of the diameter of the tank. The tank proper is 51ft in diameter and there is a range in head of 26ft between the low and high-water levels. The eight cylindrical columns are fabricated from steel plates ½in thick, rolled to a 42in diameter. The central riser is 6ft in diameter.

New Low Temperature Laboratories

New low temperature laboratories in the Division of Mechanical Engineering of the National Research Council have just been completed. In the past only very limited laboratory facilities for small-scale tests have been available in Canada. In recent years bases for field testing have been established as far north as transportation conditions permitted, but development work there is hampered by weather changes and by the long supply routes. In the low temperature laboratories it will be possible to produce any desired combination of temperature and wind throughout the year and to hold the conditions constant. Tests in the cold chambers should be less expensive than field tests.

Three cold chambers are available, the largest of which is capable of accommodating test specimens up to 50ft by 15ft by 12ft. Temperatures as low as minus 80 deg. Fah. may be obtained in all of the cold rooms. Associated refrigeration plant has a capacity of 250 tons and requires a total driving power of 1000 h.p. In the case of the large chamber, with a " dead " load of 40 tons, the load temperature can be lowered to minus 80 deg. Fah. in about sixteen hours and can be held with an internal heat load of 165kW. In the small rooms, with no load, the temperature can be dropped from plus 80 deg. Fah. to minus 80 deg. Fah., in as little as fifteen minutes, and the process can be readily reversed by operating the defrosting system. The chamber construction consists of a wooden frame with metal panel type of insulation known as " Ferrotherm." This consists of a series of thirteen thin panels of steel with a lead-tin alloy protective coating spaced approximately ¼in apart. It is in effect an " air-gap " insulation with radiation insulation provided by the bright metal surfaces.

The refrigeration plant, one of the largest of its kind in Canada, was installed by the Canadian Ice Machine Company of Toronto. A three-stage direct expansion ammonia system is employed with reciprocating compressors driven by synchronous electric motors. The first stage consists of three four-cylinder compressors, the second stage of one four-cylinder compressor and the third stage of two smaller two-cylinder compressors. Inter-stage ammonia intercoolers are provided and the hot gases are finally liquified in water condensers supplied with cooling water from a spray tower at the rear of the laboratory.

Machine for Tree Seed Extraction

Recently the Minister of Lands and Forests of the Province of Ontario announced the completion of a tree seed extraction machine designed and built by his department. To carry out reforestation on a worthwhile scale large quantities of tree seeds are required to produce the seedlings which are distributed free to landowners from the Provincial nurseries. Indeed, as many as 20,000,000 of these seedlings have been sent out in one year. Three years ago the Department of Lands and Forests started development of a compact machine using heat from infra-red lamps to open the seed cones. Recently an improved machine was made and tested successfully on a small scale. It comprises a cone hopper, from which closed cones are fed to a moving, slatted conveyor and carried under banks of infra-red lamps, which are adjustable for distance and hence for heat intensity. The heating action partly opens the cones and the seeds drop through the slats. Midway through the machine the cones are immersed in water, which closes the cone scales. Subsequent heating reopens the scales to a greater extent and a larger seed recovery is thereby obtained.

New Steam Generating Plant

The Hydro-Electric Power Commission of Ontario has announced plans for the construction of a 21,000,000 dollar steam plant for generating electricity. The plant will be built at Detroit. The first large plant of this kind to be erected in Ontario and the largest steam-generating plant in Canada, it will generate 60-cycle power to conform with the commission's decision to change its equipment to this frequency. The plant will have an initial capacity of 120,000kW but the site and capacity of certain ancillary facilities will provide for an ultimate output of 240,000kW.

Steel

Steel production in Canada reached a high point in March with 286,000 tons produced, compared with 240,000 the previous month and 270,000 in March last year. Output for the first quarter of the year was 782,000 tons, compared with 748,800 in the similar period last year. Pig iron production in March was 172,700 tons, compared with 151,100 in February and 164,400 in March, 1947, with first-quarter production totalling 483,800 tons, against 492,300 in the first three months of 1947. Production of ferro-alloys in March totalled 14,300 tons, against 11,800 in February and 14,200 in March last year.

Large Rolling Stock Order

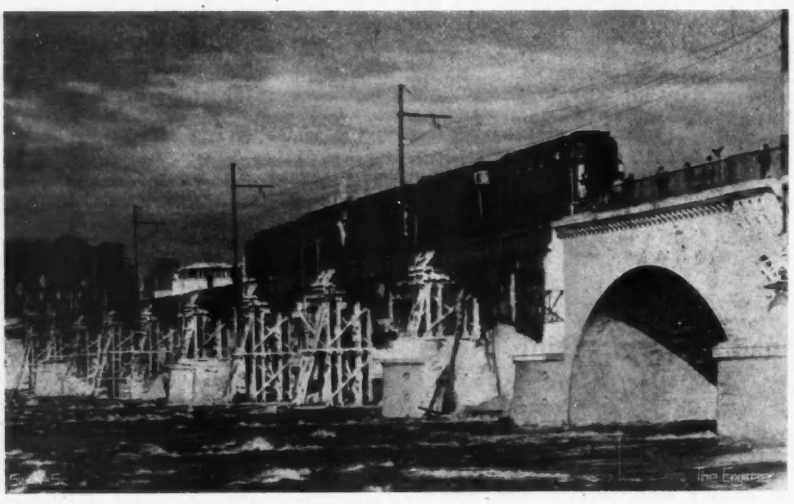
The Canadian Pacific Railway Company has authorised more than 31 million dollars in new equipment orders for 1948, including 44 diesel locomotives, 2100 freight cars and 115 passenger cars. When combined with a more than 32 million dollar carry-over of orders from previous years on which the railway is awaiting delivery, this brings to more than 63 million dollars the value of motive power and rolling stock contracts outstanding.

Reconstruction of French Railway Bridges*

By R. DUGAS and L. CARPENTIER†

If you had the opportunity of making a journey in France, you would, no doubt, display particular interest in the working of the railways, the condition of their installations and the progress of reconstruction.

Here and there, temporary buildings, a station under repair, workshops under reconstruction, or a speed restriction over a bridge would remind you that the railways are still engaged in healing the scars of war. Nevertheless, the services available to the traveller are once again of a standard comparable with that provided before the war. The train ferry service again provides a very pleasant link between London and Paris; there is once again a service between Paris and Bordeaux in six hours; from Paris to Nice in fifteen hours; while Lyons, 500km (310 miles) from Paris, can be reached at an overall speed of 100km (62 miles) per hour, and soon Strasbourg will be linked with Paris in five hours by a high-speed service of railcars on pneumatic tyres.



Bridge over the Loire at Orléans

It is difficult to appreciate the enormous progress made during the three years and the magnitude of the effort put forward by railwaymen of all grades in order to restore the French railways to the condition they are in to-day.

The year 1944 saw the systematic air attacks on bridges, on railway tracks, and on marshalling yards, while, at the same time, a scheme of line cutting was being carried out by the various Resistance Movement organisations, often under the guidance of railwaymen themselves. The German retreat brought in its train the final stage in the complete wrecking of the railway system, with its quasi-systematic destruction, quite frequently without the slightest regard to the strategic significance of the bridges and viaducts.

In September, 1944, the French railways had been brought to a condition in which they were, for practical purposes, unworkable.

It was with very limited resources at his disposal, and frequently left to his own devices, as in the upper valley of the Maurienne, which was rendered inaccessible by the cutting of the twenty-seven railway bridges as well as all the road bridges, that the French railwayman set himself to the task of reconstruction, and temporary bridges were quickly put up in all parts of the country.

The Allied armies constructed a number of bridges, but these were often comparatively unimportant structures and on routes which, owing to the strategic considerations then prevailing, happened to be important for the supply of the armies, although the lines in question were not regarded as main or important lines from the French railway point of view.

The French National Railways were not taken by surprise by the events of 1944, and they had made plans, as far as they were able in the circumstances, for immediately starting work of reconstruction.

Thus, even before the Liberation, the Central Bridge Department had prepared standard designs for temporary timber piling, for short and medium-span bridges in steel, masonry and reinforced concrete and for standard arches. These designs were circulated to all parts of the system so that, when the time came, the staff, even in the most isolated areas, could at once put in hand the most effective arrangements to bring about the rapid resumption of traffic.

In order to marshal these limited resources, to co-ordinate their use and to allocate them according to the urgency of the operating position, the special Reconstruction Division, which had carried through in less than two years the rebuilding of the bridges destroyed in 1940, was reconstituted and placed under the immediate control of Monsieur Luduc, who was responsible to Monsieur Robert Levi, chief civil engineer.

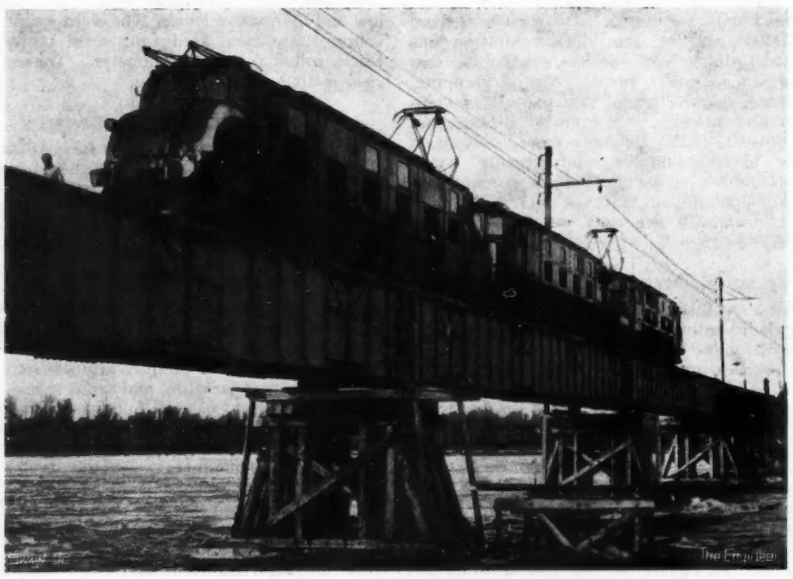
Work was put in hand at every location for which it was possible to find contractors able to undertake the work, and for which materials were available. The type of temporary bridge to be built in each instance was, in principle, determined in the light of local conditions, of the urgency with which the work had to be completed, and of the proposals under consideration for the new permanent bridge.

In the period immediately following the Liberation, the urgency of restoring traffic and the influence of conditions at the site were the determining factors. The practice was to size up the situation and to adopt whatever methods would enable these requirements to be most rapidly met. Frequently it was found that the wreckage of a destroyed bridge could, in many cases, be used to provide a more or less satisfactory support for the temporary structure, so long as one did not adhere unduly rigidly to the normal rules and practices of bridge building. The bridge over the Loire at Orléans is a notable example of boldness of this character. Nevertheless, it stood up valiantly to the flood waters and ice floes of the Loire, until it was finally dismantled a few months ago. For the bridge over the Rhône at Lyon-Perrache it was possible to make use of the dismantled superstructure of the destroyed bridge to provide an intermediate support in the temporary bridge. In other places, light steel trestles were built up on the main foundations of the piers due to be rebuilt, and, subsequently, were encased by the masonry of the piers forming the new permanent structure. In the Canardière viaduct, near Chantilly, on the main line from Paris to Calais, the piers were strutted adjacent to the breach in order to prevent the collapse, through lateral thrust, of those arches in the viaduct remaining still intact.

At a later stage supplies of English steel trestles provided the means of constructing a more satisfactory type of bridge, such as that at Argenteuil-Orival. Here the foundations were built of piles capped with reinforced concrete slabs. This method made it possible to secure satisfactory arrangements for the driving-in of the piles, without having to restrict their siting to within narrow limits to which it would be difficult to adhere on account of the wreckage at the site.

Once the most urgent routes had been reopened to traffic, it became the practice in constructing temporary bridges, to give considerable weight to the requirements of the permanent bridge to be built at a later date, providing this did not seriously delay the provision of the temporary bridge.

Whenever possible, the temporary bridge was built for a single track, or for two tracks



Temporary Bridge at Montlouis

* Paper read before the Railway Students' Association, March 10th, 1948. Abridged.

† Executive Assistant (Technical) to the General Manager and Engineer of Bridges, Chief Engineer's Department, French National Railways (S.N.C.F.).

interlaced, so as to allow the permanent bridge to be built in two halves one side at a time—and the tracks transposed; this practice was generally followed in the case of bridges being built in masonry or reinforced concrete. Sometimes even the emergency bridge was built in such a way as to allow of the complete reconstruction of the piers, as, for instance, in the case of the large bridge over the Loire at Montlouis, near Tours.

In the case of this bridge, with its twelve arches of 90ft span each, the temporary structure was built of continuous beams, of constant section, in such a way that, once the line had been quickly restored to traffic by using the debris to form supports for the beams, fresh intermediate supports—also of a temporary character—were built, making it possible then to undertake the reconstruction of the piers

Temporary Bridge at Montlouis

and the building of the new permanent bridge. When this procedure could not be satisfactorily followed, owing to the nature of the wreckage (for instance, twisted steelwork), or on account of the requirements of the new permanent bridge, we did not hesitate to have recourse to a deviation of the alignment.

An example of a complicated problem was the Caronte bridge near Marseilles, which involved the restoration to traffic of a viaduct which included a swing span, 114m long, in two halves of equal length, and also a fixed span, 52·50m (172ft) long, which had collapsed. The work had to be done without prejudicing the construction of the permanent bridge and also with the minimum of interference to navigation. The viaduct crossed a navigable lagoon nearly 1200m in width, at a maximum height of 23m so that the construction of a deviation was out of the question. The problem was solved by temporarily replacing the swing span by a lift span, which afforded a clear passage up to 40m in height for ships keeping strictly to the channel. This span was supported by steel towers, anchored partly to a section of the abutment of the former bridge and partly to a gantry built of reinforced concrete, the legs of this gantry being clear of the central pier of the final bridge. The space between the gantry and the other abutment was crossed by a fixed built-up steel span. During the construction of the lift span the approach span was also raised.

In carrying out the permanent reconstruction, after the pier is complete and the driving mechanism installed, the new swing span, which will be of a similar design to the old one, will be erected parallel to the navigation channel, and trains will continue to run through the steelwork in course of erection; only the fitting of a cross-brace on its bearing will be held over. It will, therefore, be possible, with only a short interruption of traffic, to take out of service the temporary bridge and to place the swing span into its closed position.

As a result of the speed with which work was pressed forward on the lines indicated, no less than 1450 bridges had been reopened to traffic in their temporary form by the end of 1944.

Nevertheless, even though the completion of this first stage enabled the most pressing needs to be met, it involved numerous restrictions which it was essential to eliminate at the earliest possible moment. Thus, the piles in the rivers needed close and constant watching; there were hindrances to navigation, and, above all, there were the serious speed restrictions on trains, which both lengthened the journey time and resulted in an appreciable increase in coal consumption. On January 1, 1945, the speed restrictions over temporary bridges, throughout the system as a whole were involving the consumption of approximately an additional 1000 tons of coal per day.

In these circumstances permanent reconstruction work was put in hand the moment that the availability of materials and of contractors permitted.

Permanent Reconstruction Work

This work fell into two main categories—the repair of bridges in their original form and the construction of entirely new bridges. In the first category the most intricate work was that involved in the repair of steel bridges, which included, each time that it was possible without excessive expenditure, the lifting of the demolished spans.

Repair work on girders in position was carried out on traditional lines. It was, nevertheless, always both a long and delicate task, owing to the numerous interruptions for planning and trying out ideas necessitated by the diverse character of the new steel sections available, and also of that in the old bridges.

The lifting of demolished spans, even if it was not always very economical, did, however, make available the maximum amount of steel for use in the reconstruction work and, thereby, make possible the rapid resumption of traffic.

This type of work, which was new to us in 1940, had, by 1944, become almost a traditional practice, and it proved possible to recover some forty large bridges in this way.

An example of this work was the lifting of a span 75m long, weighing 500 tons, at the Cubzac bridge over the Dordogne, near Bordeaux, including the restoration to its correct position of a steel pier which was torn from its base and inclined at an angle 4 deg. out of the vertical.

The solution adopted, which was a very bold one, involved the use of the fallen truss acting as a balance weight to pull the pier back into its correct position. The weight of the truss was transferred to the front of the pier, through the intermediary of live rollers, in such a way as to bring about the movement of the pier towards its correct position. It then proved sufficient to allow the legs of the pier to move gently back on to the bearings from which they had been torn by the collapse of the truss.

In the repair of masonry bridges use was made of rough rubble with thick joints in such a way as to re-use the materials recovered from the destroyed bridges. General use was made of concrete above the soffit, which was, as far as possible, built in masonry with some binding bars tying the masonry and concrete. The application of an interesting technique of expanding cement made possible the carrying out, under pressure, of the repair of local damage in the arches and led to a proper redistribution of stresses as between the repaired and the sound portions of an arch.

The bridges which involved complete reconstruction were much more numerous than those needing repairs; in most cases the destruction was so complete. Advantage has been taken of the opportunity afforded by the need to reconstruct so many bridges, to improve them, especially from the railway point of view, and by providing bridges of such a type that the track can be laid on ballast, thereby reducing maintenance to a minimum. We have, therefore, adopted the following order of preference: —masonry bridges, reinforced concrete bridges, and, lastly, steel bridges. Steel, which was in short supply, has been reserved for the most difficult works, namely, long spans; sites where the depth of the bridge was restricted and where the span had to be erected away from the site.

Masonry bridges have been built everywhere where local conditions and the ability to obtain supplies of cement permitted. As in the repair work, we have been obliged, for reasons of economy, to combine the use of concrete and stonework, and to confine the use of stone to the exterior finishing and decorative work (head bands, spandrels and soffits).

We have not hesitated to draw on the results of laboratory investigations into the resistance of concrete to fatigue, and to use the experience gained in a few bridges built before the war, and on a much wider scale in 1940, to extend the field for the application of reinforced concrete work to bridges with continuous or independent straight beams.

The field for reinforced concrete appears to us to be capable of further expansion by the improvement of the quality of the concrete, due to a more careful grading of the fineness. The methods developed by Monsieur Vallette, chief of the bridge division, have made it possible to prepare on the site concrete with a basis of 6cwt of cement per cubic yard, having a resistance of 6000 lb per square inch, the ratio of water to cement being 0·40.

Conclusion

I have described to you the most striking of our various achievements in the sphere of bridge construction. As a result of our efforts 1850 bridges had been rebuilt in their permanent form by December last—that is, about three-quarters of those which were destroyed.

The work has had to be carried out in the face of difficulties, which, while less spectacular, were no less serious; designs had to be changed two, three or four times to take into account a combination of circumstances: the changing economic situation, the plans for the allocation of costs, irregularities in the supplies of materials, electric power cuts, and, most recently, the curtailment of credits.

The results achieved can, in these circumstances, be regarded as a cause for satisfaction. I trust I may be allowed to claim that this success has been due not merely to that ardour which one always displays in rebuilding one's home, but to that magnificent *esprit de corps*, which, in France, as in England, too, I am sure, makes all we railwaymen members of the same, and large, family.

Industrial and Labour Notes

The Development Areas

In the course of a Committee of Supply debate in Parliament last week on the Board of Trade vote, reference was made to the distribution of industry and to progress in the Development Areas of Great Britain. Mr. G. R. Chetwynd, of Stockton-on-Tees, asked the President of the Board of Trade to consider seriously at this stage allowing more steel to be used for the construction of factories in the Development Areas, on the ground that such a policy would pay rich dividends in exports and also in production for the home market. He suggested, too, that the factories now under construction should be completed as quickly as possible, as many of them, he said, had been on the way for eighteen months or two years, and tenants were becoming a little tired of the delays.

In winding up the debate, the President of the Board of Trade, Mr. Wilson, reminded the committee that, within three years of the passing of the Distribution of Industry Act, he was required to review the whole operation of the Act and consider whether any new areas should be scheduled as Development Areas, or existing areas taken off the list. A White Paper giving the results of that review and an account of the experience in operating the Act over the past three years would, he said, be issued in the next two or three weeks.

Dealing with the progress of factory building, Mr. Wilson said that the total programme covered 1212 factories or extensions, designed to provide employment for 223,000 people in the Development Areas. Of that programme, 368 factories and extensions costing £13,600,000, had been completed and although many of them were not yet up to full employment, 26,000 workers were already engaged in them. A further 565 factories, costing £53,000,000, were in course of construction and they would provide employment for another 158,000 workers. Mr. Wilson stated also that forty-nine other schemes had been approved and those factories already completed, in course of construction, or about to be started, would between them account for 187,000 of the number of people mentioned in the original programmes. The cuts in the capital investment programme, therefore, represented a postponement of 16 per cent of the original programme, and that amount was spread fairly evenly between the various Development Areas.

The Ten Per Cent More

The Trades Union Congress has prepared, for distribution amongst trade unionists, a leaflet entitled "Ten Questions about that extra Ten Per Cent." Arranged in the form of question and answer, the leaflet is designed to show how workers can help to raise output. Amongst other things, the leaflet states that there are very few industrial plants in this country which cannot increase production by 10 per cent or more by cutting out waste; waste of labour, time, materials, fuel and power. Scrap, too, it is observed, must be kept down to a minimum and then put to salvage to be used again.

Another answer in the leaflet deals with the changeover of labour in factories, saying that excessive changes among workers employed—and excessive absenteeism—are symptoms and "not the disease itself." The causes, it is asserted, may be the recruitment system, or supervision, or "square pegs put into round holes." The leaflet then discusses production costs, pointing out that they fall into three main groups—materials, labour and overheads. In these days of controlled purchase of raw materials, it is suggested there is not much that a firm can usually do about costs of materials except to reduce waste and prevent spoiled jobs, "so the blame for high-cost production is usually put down to wages, while overheads are forgotten." But, the leaflet continues, "do not run away with the idea that if overheads at your firm are equal to the total wages bill, then the firm is inefficient. It may be a very highly mechanised plant with relatively few workers, or one with an expensive laboratory. On the other hand, there may be 'fads' in the plant or there may be too many 'systems,' with the resulting employment of too many non-productive workers."

The leaflet concludes with some comments on joint production committees, and records that in over twenty industries both sides are discussing national agreements for such committees. In one existing agreement, it says, the functions of a joint production committee are described as "to consult and advise on matters relating to production and increased efficiency for this purpose, in order that maximum output may be obtained from the factory." Illustrative of the questions to be considered and discussed are maximum utilisation of existing machinery; upkeep of fixtures, jigs, tools and gauges; improvement in methods of production; efficient use of the maximum number of productive hours; elimination of defective work and waste; inefficient use of material supplies and efficient use of safety precautions and devices.

A Policy for Real Wages

Another recent T.U.C. publication is a pamphlet entitled "A Policy for Real Wages." It urges members of trade unions to be loyal to the policy on prices, wages and exports agreed upon by the recent conference of their executives. That policy, it is emphasised, was freely shaped and voted upon. "We expect others to play their part," the T.U.C. pamphlet says, "yet, with so much at stake, with so much to lose by inflation and unemployment, and so much to gain by a real and regular wage, the workers and their unions must not be laggard in setting an example to the rest of the community." In other words, trade unionists are urged to recognise that what matters most to-day is not the size of the wage packet but what the wage packet will buy.

Interim Index of Industrial Production

A provisional calculation of the interim index of industrial production, based on a limited amount of data, shows that the volume of production in March was 119 per cent of the 1946 average, compared with 125 per cent in February. In March, 1947, owing to the fuel crisis, the figure was 99 per cent. The preliminary calculation, it is stated, shows a slight falling-off in the level of activity during March, a fact which is attributed to the loss of production over the Easter holidays.

An Industrial Health Congress

The ninth International Congress of Industrial Medicine is to be held at the Caxton Hall, London, S.W.1, from September 13th to 17th, and it is expected that about 1000 medical and scientific specialists in industrial problems will participate in it. Arrangements are being made to receive 500 delegates from overseas.

The Congress will deal with the universal problem of maintaining the health of all industrial workers and the discussions, it is announced, will not be entirely academic. The programme includes papers on such topical subjects as the medical problems of mining, and on such matters as incentives, absenteeism, and the psychological effect of environment. The last International Congress of Industrial Medicine was held in Frankfurt in 1938.

The Steel Industry and Government Control

Addressing the annual meeting of the Lancashire Steel Corporation, Ltd., the chairman, Mr. J. E. James, expressed the view that if less rigid control was exercised by the Government departments concerned, and fuller advantage taken of the steel industry's commercial experience, much could be done to obviate over-ordering of steel, with its attendant maldistribution. Mr. James said that in order to achieve the full benefit of increased production, steel must flow with greater rapidity through the industries manufacturing the finished articles, for which it was required. It should not, as was too often the case at present, be held up at varying stages, awaiting some small additional parts before despatch to customers could be accomplished.

Mr. James also made some observations on the nationalisation of the steel industry and on the inevitable disruption it would involve whatever method might be contemplated. He contended that none of the many serious objections to the nationalisation of the industry had been answered in a manner calculated to relieve the apprehensions of those who had an intimate knowledge of the industry's manufacturing processes. He could not help but feel that the present period of crisis in the economic affairs of the country was surely not the time to carry out a dangerous experiment of the kind. Mr. James said, however, that he was proud in the knowledge that this complicated and intricate industry had not departed from its national duty to proceed with the work of repairing the ravages of years of war on its machinery and equipment, and, in addition, to go forward with extensive agreed plans to improve its efficiency. The industry, he concluded, had done all those things knowing full well that unless iron and steel production ran at its highest level and was obtained at competitive world prices, this country could not hope to maintain and improve its present standard of living.

Tin Prices

The Ministry of Supply has announced new buying prices for Malayan tin metal and Nigerian tin concentrates, which took effect from June 1st. The buying price for Malayan metal has been increased from £504 to £554 per ton ex smelters' works (Penang or Singapore), and the buying price for Nigerian tin concentrates has been increased from £485 10s. to £535 10s. per ton of tin in ore f.a.s. Nigerian port. The selling price of Malayan metal has been raised from £505 10s. to £555 10s. per ton ex smelter (Penang or Singapore).

The Ministry has also stated that on and from June 1st the United Kingdom selling price of tin metal of minimum 99 per cent up to under 99·75 per cent tin content, has been increased from £519 to £569 per ton, f.o.b. U.K. port or delivered U.K. consumers' works. The prices of other grades have been correspondingly varied as follows: refined tin 99·75 per cent minimum, from £522 10s. to £572 10s.; refined tin 99·9 per cent minimum in 28 lb ingots, from £527 to £577; grain bar tin, from £539 to £589, and granulated tin, from £544 to £594. The customary extras for small lots, packing, &c., apply.

Coal Output

The saleable output of deep-mined coal in Great Britain was less than 4,000,000 tons a week during the month of May. Figures issued by the Ministry of Fuel and Power show that in the four weeks ended May 8th, 15th, 22nd, and 29th, production was 3,842,400 tons, 3,874,200 tons, 2,951,900 tons, and 3,957,700 tons respectively. In the same weeks the output of opencast coal was 278,100 tons, 308,600 tons, 209,500 tons, and 279,800 tons. The drop in output in the week ended May 22nd indicates, of course, the effect of the Whitsun holiday, it being estimated that 790,900 tons were lost through "recognised" holidays. Last week the coal lost through holidays, disputes and other causes was 49,120 tons.

In the first twenty-one weeks of this year, up to May 29th, coal output totalled 85,069,300 tons, compared with 79,647,000 tons in the corresponding period last year.

French Engineering News

(From our French Correspondent)

The Associations which, together with responsible Ministries, formerly organised the distribution of surplus machine tools, now consider that the situation of the country has sufficiently improved to make a return to commercial liberty possible and are refusing to take the responsibility of choosing between their members. Most of the Associations are in favour of offering the surplus machines, which are the property of the State, through ordinary public sales. Some sales have already taken place, but it is important that they should take place more rapidly because about 700 machines arrive each month and covered storage area is limited. It is thought that sales will reach 1200 machines a month, including those arriving from Germany and those already in France.

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Improvements in the handling of coal have been made at the Gennevilliers thermo-electric plant. Two new 100,000kW generators, each consuming 1000 tons of coal daily have been installed. The four old 40,000kW and 50,000kW generators use a total of 2000 tons daily in winter. Thus, an average of 4000 tons of coal daily is needed for the coal handling installation. Stocks must be between 150,000 and 200,000 tons and reception possibilities between 6000 and 7000 tons daily, compared with the old installation, which could stock 40,000 tons and handle 200 tons an hour. The new installation now being completed comprises a coal depot which can receive, distribute and send out up to seven loads of 1000 tons daily, with unloading area for trucks with the same capacity. It will also have an unloading area for barges, capacity being 4000 tons daily. The whole installation will be ready for the winter of 1948–49.

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The Davy-Faraday Exhibition now showing at the Palais de la Découverte in Paris will be open to the public until the end of July. Exhibits, bearing on the life and work of the founders of electro-chemistry and electro-magnetism, have been lent by the Royal Institution and the British Museum. Original publications of their researches are shown. A large hall has been reserved to show some of the applications of the discoveries of Davy and Faraday to present-day transmission of electric power, to the automatic telephone and to the electro-chemical industry. Latest improvements in automatic telephone exchanges are shown by both the British and French Post Offices. The French Post Office has announced that in two years' time all telephone subscribers in Paris will be able to call other large French cities by automatic dialling.

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Monthly oil refining capacity of the Raffinerie de Normandie, which was 100,000 tons at the end of 1947, rose to a record of 170,000 tons in April, 1948. Stocking capacity, which fell almost to nothing at the Liberation, is now 100,000 tons, which is a twenty-days' supply. Fortunately, the plant is equipped to treat all types of products, so that supplies from various quarters can be taken. Less oil is now being received from the United States, and Venezuelan supplies now represent 50 per cent of consumption. This proportion will fall to 30 per cent when the refinery is working to capacity. The main source of supply will become the Middle East, which will, in the future, supply 100 per cent of French needs. When new pipe lines have been completed, in 1949 or 1950, Iraq will supply 6,000,000 tons, against 1,000,000 tons pre-war. French refining capacity, to-day 90 per cent rebuilt, will be increased to 15·5 million tons in 1955, or almost twice the pre-war figure. Refineries complain, however, that they do not receive sufficient steel, only 38,000 tons having been allocated between the Liberation and the end of 1947, although they asked for 100,000 tons a year for three years. Steel allocations for refineries will be increased to 17,550 tons for the second quarter of 1948, against 8300 tons for the first quarter.

Notes and Memoranda

Air and Water

INSTITUTE OF NAVIGATION.—The first annual dinner of the Institute of Navigation is to be held at the Charing Cross Hotel, London, W.C.2, on Friday, July 2nd. H.R.H. the Duke of Edinburgh has graciously accepted an invitation to be the guest of honour.

H.M.S. "ALAMEIN."—H.M. Flotilla Leader "Alamein," which has been constructed by R. and W. Hawthorn, Leslie and Co., Ltd., at the Hebburn Shipbuilding Yard, was commissioned on April 30th and proceeded on her official sea trials on May 4th. The trials have now been completed satisfactorily and the vessel was handed over to the Admiralty on May 21st. H.M.S. "Alamein" has a displacement of about 2200 tons, with a two-shaft arrangement of geared turbines of a total s.h.p. of 50,000. Her armament consists of twin 4·5 Q.F., twin 40mm. Bofors, and 21in torpedo tubes.

AERODROME AND AIRBORNE EQUIPMENT.—An exhibition of British aerodrome and airborne equipment is to be held shortly at the Régie Aeronautique, Boulevard du Regent, 53, Brussels. It has been organised by leading British manufacturers in conjunction with the Belgian Air Ministry. Among the exhibits will be a selection of both types of equipment made by the General Electric Company, Ltd. Ground equipment will be represented by high and low intensity approach lights, a runway contact light and the new taxi track light, which is also suitable for use as a low intensity runway contact light. Samples of various types of Pirelli-General aircraft cable will also be on view. The airborne exhibits, all of which are manufactured by Salford Electrical Instruments, Ltd., will include the radio compass, the radio sonde apparatus for conducting meteorological surveys, and a new magnetic tape recorder.

GERMANY'S WARTIME SHIPBUILDING.—A critical review of all the B.I.O.S., C.I.O.S., F.I.A.T. and J.I.O.A. reports on Germany's shipbuilding and marine engineering advances during the war period has now been published under the title "B.I.O.S. Overall Report No. 2." It has been specially written by the British Shipbuilding Research Association. Among the subjects covered in the report are: ship construction, boilers and steam propulsion, gas turbines, steering devices, auxiliary machinery, and cargo handling equipment. The report analyses the differences between British and German practices and points to some interesting features. Commercial competition was planned to the "Queen Elizabeth" by the construction of a 300,000 h.p. vessel developing a speed of 36 to 38 knots. The construction of concrete ships as an emergency measure was undertaken and they proved quite successful. A model had been developed which combined a gas turbine and a rotary steam boiler which had run at 5000 r.p.m., giving 200 h.p., working up to 2372 deg. Fah. Much research and development work went on in Germany to use gas turbines for ship propulsion. The report is obtainable from H.M. Stationery Office, Kingsway, W.C.2 (S.O. Code No. 51–283–2, price 6d.).

Miscellanea

LINCOLN'S INCENTIVE SYSTEM.—Mr. James F. Lincoln, President of the Lincoln Electric Company, is to speak on his company's incentive system at a combined meeting of the Institute of Industrial Administration and the Institution of Production Engineers on July 1st.

THE INSTITUTE OF PHYSICS.—At the recent annual general meeting of the Institute of Physics, Dr. F. C. Toy was elected President, and Dr. T. E. Allibone was elected Vice-President. The report for 1947 shows that the membership of the Institute has increased to about 3250, there being seven branches at home and overseas. The report mentions that during the past year the Institute has concerned itself with professional affairs and is represented on the Joint Council of Professional Scientists.

THE CIVIL ENGINEER IN WAR.—Last year the Institution of Civil Engineers convened a conference at which twenty papers dealing with wartime engineering problems were read and discussed. These papers, together with forty-seven other contributions on wartime engineering matters, are to be published by the Institution in a book, which it is hoped will be available in three volumes in a few weeks' time. The subjects dealt with include airfields, roads, railways, and military bridging; docks and harbours, with a special section on "Mulberry"; materials, structures, hydraulics, water-supply, tunnelling and surveying. The Admiralty, War Office, Air Ministry and other Government Departments have co-operated with the Institution in the preparation of the book, which will undoubtedly present a comprehensive and authoritative account of the chief engineering works of the war. The price of the three volumes is two guineas, and orders may be sent to the Institution of Civil Engineers, Great George Street, Westminster, S.W.1.

PRICES OF ELECTRIC MOTORS.—The Dynamo and Motor Association announces that in support of the Government's desire to stabilise prices, and in accordance with the recommendations contained in the Federation of British Industries' Report on Prices and Profits, it has decided not to increase the present general level of prices of its industrial electric motors and dynamos. The present price level was established in March, 1947, and the Association says that despite additional costs incurred since then the prices will remain at that level as long as the costs of labour, raw materials and services do not increase.

"FUEL AND THE FUTURE."—The proceedings of the "Fuel and the Future" Conference held in London by the Fuel Efficiency Committee of the Ministry of Fuel and Power in October, 1946, have now been published by H.M. Stationery Office in three volumes. Volume I deals with the generation and utilisation of steam, including its use for combined power generation and process heating. It also deals with the use of heat for drying, factory heating and air conditioning, and heat for agriculture and horticulture. Volume II discusses high-temperature processes and gas producers, oil firing, the carbonisation and the chemical industries, and Volume III covers the domestic side of fuel use, including modern heating and the architect, the home and its fuel services, and, finally, district heating.

A PAPER SHREDDING MACHINE.—A paper shredding and crinkling machine, designed to turn waste paper into packing material, has been produced by Sunbeam Commercial Vehicles, Ltd., Wolverhampton. Confidential documents, which are usually burnt, can be shredded by it to 3mm and their contents made unrecognisable, so that they can be used for packing. The machine occupies a floor space of only 3ft by 2ft 3in, and is simple in operation with press-button control. Electric current consumption is said to be very small. The paper is fed by hand into the machine, and passes between a double bank of cutters, complete protection being afforded to the operator, as no moving parts are exposed. The shredded and crinkled paper falls into a removable hopper. A storage cabinet for paper before shredding has been incorporated in the design.

EDINBURGH'S GAS UNDERTAKING.—This year marks the diamond jubilee of the joint acquisition by the municipalities of Edinburgh and Leith of the two private gas light companies, which operated there prior to 1888. It is also the 130th anniversary of the first distribution of gas in the supply area. Under a policy of centralised production Granton Gas Works were constructed by the Gas Commissioners at the beginning of the century on a spacious site adjacent to the Firth of Forth. Since full control of the undertaking was first exercised by the City of Edinburgh in 1920 the original inclined retort installations and water gas units have been completely replaced by modern installations of continuous vertical and of carburetted water gas retorts. This year an additional installation of carburetted water gas plant has been completed. Contracts recently placed for further plant will bring the production capacity up to 30,000,000 cubic feet per day, making Granton works the largest unit in Scotland.

TWO B.I.S.R.A. CONFERENCES.—To help bridge the gap between science and industrial application, two conferences are planned by the British Iron and Steel Research Association for next autumn. Each is to be held at Ashorne Hill, near Leamington. The first conference has the support of the Institute of Physics, and will be held on September 8th and 9th to discuss non-destructive testing of castings. It is intended that the papers presented shall deal essentially with practical aspects and be of interest to executives not conversant with the methods, but who might be considering their use. The second conference is planned for October 21st and 22nd, and will deal with foundry core bonding agents. The object is to bring to the notice of founders the wealth of information that has been obtained in recent years on the new materials that may be used for the bonding of foundry cores. The use of such materials, in many cases with an appreciable reduction in cost, would enable the linseed oil, used hitherto, to be diverted to alleviate the shortage of edible fats.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Incorporated Plant Engineers

To-day, June 4th.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham. "Food Processing Plant and its Maintenance," L. D. North. 7.30 p.m.

Thursday, June 10th.—NEWCASTLE-UPON-TYNE BRANCH: Y.M.C.A., Connaught Rooms, Newcastle-upon-Tyne. Discussion on "Roller Bearings." 7.30 p.m.

Institute of British Foundrymen

Tuesday to Friday, June 8th to 11th.—Annual conference in London. Conference office at Café Royal, Regent Street, W.1.

Institute of Petroleum

Wednesday, June 9th.—26, Portland Place, W.1. "Fundamental Work on Combustion in Germany," D. S. Petty, E. P. Wright and H. L. West; "Compression Ignition applied to the Otto Cycle: The Ring Process," M. O'Farrell; "Fundamental Work on Friction, Lubrication and Wear in Germany," E. D. Tingle; and "Major Developments in Synthetic Lubricants and Additives in Germany," H. L. West. 4 p.m.

Institution of Gas Engineers

Tuesday to Friday, June 8th to 11th.—Friends' House, Euston Road, London, N.W.1. Annual general meeting.

Institution of Heating and Ventilating Engineers

Monday, Tuesday and Wednesday, June 21st, 22nd and 23rd.—Burlington Hotel, Boscombe, Bournemouth. Summer meeting.

Institution of Mechanical Engineers

Tuesday, Wednesday and Thursday, June 15th, 16th and 17th.—Glasgow summer meeting.

Institution of Mining Engineers

Wednesday, Thursday and Friday, June 9th, 10th and 11th.—Neville Hall, Westgate Road, Newcastle-upon-Tyne. Summer meeting.

Institution of Production Engineers

Tuesday, June 8th.—WOLVERHAMPTON GRADUATE SECTION: Technical College, Walsall. Film show, "Wheels Behind the Wheels." 7.15 p.m.

Iron and Steel Institute

Tuesday, June 22nd.—4, Grosvenor Gardens, London, S.W.1. Iron and Steel Engineers' Group meeting. 10.30 a.m.

Women's Engineering Society

Thursday, June 10th.—LONDON BRANCH: 35, Grosvenor Place, S.W.1. Annual general meeting, followed by technical films. 7 p.m.

Catalogues

BUTTERS BROTHERS AND CO., Ltd., McLellan Street, Glasgow, S.1. Illustrated catalogue dealing with electric Monotower cranes.

E. H. JONES (MACHINE TOOLS), Ltd., Edgware Road, The Hyde, N.W.9. Illustrated booklet describing the E.H.J. organisation.

VISCO ENGINEERING COMPANY, Ltd., Stafford Road, Croydon. Booklet entitled "Modern Dust Collection and Fume Removal."

W. EDWARDS AND CO. (LONDON), Ltd., Kangley Bridge Road, London, S.E.26. Booklet dealing with high-vacuum equipment.

J. K. SMIT AND SONS, Ltd., St. Margaret's House, 57–59, Victoria Street, S.W.1. Illustrated catalogues of industrial diamond tools.

THOS. W. WARD, Ltd., Albion Works, Sheffield. Catalogue of small tools, and booklet dealing with factory planning and installation.

PHILIPS ELECTRICAL, Ltd., Century House, Shaftesbury Avenue, W.C.2. Lighting publication No. A.165 describing tungsten lighting.

SIR HOWARD GRUBB, PARSONS AND CO., Walkergate, Newcastle-upon-Tyne, 6. Publication No. 14, entitled "Astronomical Instruments."

OPTICAL MEASURING TOOLS, Ltd., 414, Montrose Avenue, Trading Estate, Slough. Illustrated folders dealing with universal tool heads, universal dividing heads and the horizontal Omtimeter.

SCIENTIFIC EXPORTS (GREAT BRITAIN), Ltd., Buckingham House, Buckingham Street, Adelphi, W.C.2. Issue No. 2 of the Technical Bulletin of the Sciex Group of Companies, and catalogue of scientific precision equipment.

NEWALL ENGINEERING COMPANY, Ltd., Peterborough. Folders describing the "L.A." 10in cylindrical grinding machine, the jig borer, and the latest developments and additions to the Newall Group range of machine tools and instruments.

TUBE INVESTMENTS (EXPORT), Ltd., The Adelphi, W.C.2. Booklets entitled "Tubing and Metal Sections for the Building Trade," "Mild Steel and Stainless Steel Tubes for the Textile and Carpet Industries," and "Steel Tubes for Furniture."

Personal and Business

MR. J. E. FARRELL has been elected president of the Institution of Fire Engineers.

DR. F. LLOYD-KESSEL has been appointed managing director of Cleanette Appliances, Ltd.

MR. J. H. JELLETT has been appointed Docks Engineer, Southern Region of British Railways.

MAJOR J. C. POOLE has been elected chairman of the council of the London Chamber of Commerce.

MR. J. R. RYLANDS, M.I.Mech.E., M.I.E.E., chief engineer of E. Green and Son, Ltd., has been appointed a director of the company.

THE MINISTRY OF SUPPLY has established a North Wales regional office at "Bryn Llwyd," St. David's Road, Carnarvon (telephone, Carnarvon 268).

THE ELECTROPLANT COMPANY (G.P.U., Ltd.) announces the appointment of Lieut.-Commander C. H. Hayward as supervisory engineer in Venezuela and Colombia.

THE BRITISH ALUMINIUM COMPANY, Ltd., has moved its Manchester branch office to 46, Fountain Street, Manchester, 1 (telephone, Deansgate 3639 telegrams, "Britalumin, Manchester").

BOULTON PAUL AIRCRAFT, Ltd., announces that Dr. S. C. Redshaw, M.I.C.E., F.R.Ae.S., chief engineer, and Mr. G. C. Haynes, secretary, have been appointed directors of the company.

THE WESTINGHOUSE BRAKE AND SIGNAL COMPANY, Ltd., has announced the following appointments: Mr. T. J. Aldridge, chief Continental engineer, and Mr. C. F. D. Venning, chief signal engineer.

MR. STANLEY D. CANVIN, B.Sc.(Eng.), M.I.C.E., M.I.W.E., general manager of the Glasgow Corporation Water Department, has been elected a vice-president of the Glasgow and District Association of the Institution of Civil Engineers and also to the council of the Scottish Section of the Institution of Water Engineers.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of report	Title	Post free s. d.
B.I.O.S.		
1646	Miscellaneous Information on Fuels, Detergents and Lubricants	15 4
1669	The Use of Dismulgans for Breaking Crude and Naval Fuel Oil Emulsions	2 8
1673	German Hardened and Tempered Steel Strip Industry...	13 3
F.I.A.T.		
395	Metallurgical Practices in Germany: The Fields of Non-Ferrous Melting and Casting ...	4 2
768 (Supplement No. 1)	Phenol Manufacture in Germany by the Chlorination, Sulfonation and Raschig Processes ...	1 1
780	Methods of Measuring Scattered Light at Optical Boundary Surfaces	6 2
1003	The Chemical and Technical Basis for the Synthesis of Butadiene at I.G. Ludwigshafen ...	3 2
1119	Methods of Transmitting 2,000,000 Kilowatts of Electric Power 600 Kilometres	2 8
1123	The Precast Concrete Products Industry in Germany	6 8
1129	German Practice in Fabrication of Gas Turbine Blades	2 1
1144	Utilisation of Tall Oil in Germany: (as a substitute for Linseed Oil and Rosin in the Surface Coating and Linoleum Industries)	2 8
B.I.O.S.		
Misc. 56 ...	Interrogation of Mr. Bernhard Bisinger, Director of Textile Research of the Zwillwolle Lehr Spinnerne Denkendorf, Germany	1 1
Misc. 57 ...	Servos with Magnetic Amplifiers (Transductors)	1 7
Misc. 58 ...	Quenching Billets and Bars Directly from Rolling at Ruhrstahl, Witten	2 1
JAP/PR/1296	Japanese Navy Diesel Engines...	4 2
JAP/PR/1563	Japanese Metallurgy: Recovery of Aluminium from Clay and Shale	1 1
Classified List No. 8.—Consolidated list under subject headings of all reports on German and Japanese industry published up to and including May 31, 1947		1 3
Classified List No. 9.—June, 1947, supplement to the above list...		0 3
Classified List No. 10.—July, 1947, supplement to the above list...		0 3
Classified List No. 11.—August, 1947, supplement to the above list		0 3
Classified List No. 12.—September, 1947, supplement to the above list...		0 3
Technical Index	Alphabetical subject index of reports on German industry published up to and including July 27, 1946	5 3
Technical Index (part 2), August, September and October, 1946, supplement to the above index...		1 7
Technical Index (part 3), November and December, 1946, supplement to the above index... ...		1 7
Technical Index (part 4), January, February and March, 1947, supplement to the above index...		2 2
B.I.O.S.:		
308	The Production of Aluminium in Italy	3 2
394	Technical Report on the Ruhr Coalfield, Vol. III, Appendix No. 3: Walsum Mine: Technical Details ... ... This report has been published separately by His Majesty's Stationery Office as a Ministry of Fuel and Power publication and should be ordered by title.	3 11
944	The German Vitreous Enamel Industry	14 4
1604	German Acetylene Chemical Industry: Ethyl Acetate	2 1
1610	Fundamental Work on Friction, Lubrication and Wear in Germany	6 8
1613	Survey of Coal Preparation in the Ruhr	3 8
1655	Investigaton of Red Lead Factories in Germany	3 2
1658	Interrogation of Erwin Weise: Research and Development of Semi-Conducting Materials: Practical Applications for Ultra-Sensitive Temperature Measuring Equipment and Automatic Control and Stabilising Problems	1 1
1691	Bonding of Rubber to Metal ...	1 7
F.I.A.T.:		
956	Cellulose Sheeting and Sausage Casing Machinery and Processes	6 2
B.I.O.S.:		
JAP/PR/1154	Design of Japanese Structures ...	4 8
JAP/PR/1434	The Wood Pulp Industry of Japan	3 8
1053	German Acetylene Chemical Industry: Miscellaneous Organic Chemicals	25 6
1162	Precautions in High-Pressure Acetylene Work	4 2
1569	Further Details of German Powder Metallurgy	6 2
1660	A General Survey of the German Non-Ferrous Industry	5 2
1682	The Manufacture of Hydrazine Hydrate in Germany	4 2
1692	Mercury Arc Rectifier Practice in Germany	10 3
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Technical Information and Documents Unit, German Division, Board of Trade, 40, Cadogan Square, S.W.1, which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

A Seven-Day Journal

Civil Engineering Problems in the Colonies

A CONFERENCE to discuss civil engineering problems in the Colonies is to be held at the Institution of Civil Engineers, Great George Street, Westminster, S.W.1, from July 19th to 23rd. It will be open to members of the Institution, to engineers and other officers specially interested who are employed in the Colonial Service, and to other engineers who are engaged in civil engineering work in the Colonies. The conference will begin officially on Tuesday morning, July 20th, at 10.15 a.m., and, after an introductory address by the Right Hon. A. Creech-Jones, Secretary of State for the Colonies, the following papers will be presented :—"Development Planning in the Colonies, with special reference to Physical Development," by Sir William McLean M.I.C.E., and "Civil Engineering Problems of the East African Ground Nuts Scheme," by Mr. Desmond Harrison, M.I.C.E. On each succeeding morning of the conference, there is to be a technical session at 10 a.m., and the papers to be discussed are "Planning Road Improvement Works, Jamaica," by Mr. P. Martin Cooper, M.I.C.E.; "The Railway Gauge Problem of Tropical Africa," by Mr. R. W. Foxlee, M.I.C.E.; "Post-War Rehabilitation in Malaya," by Mr. J. O. Sanders, A.M.I.C.E.; "Problems of Labour and Materials in West Africa," by Sir Hubert Walker, M.I.C.E.; "Soil Stabilisation as applied to Traditional Building Methods in the Tropics," by Mr. A. E. S. Alcock, A.M.I.C.E.; "Malayan Roads and some Soils which Support Them," by Mr. J. J. Bryan, M.I.C.E., and Yusoff Bin Hadji Ibrahim; "An Experiment in Colonial Housing," by Mr. A. J. Mitchell, M.I.C.E.; "Notes on Anti-Mosquito Methods," by Mr. W. R. Allin, A.M.I.C.E.; "Fiji Public Water Supplies," by Mr. J. L. Brown, M.I.C.E.; "Some Engineering Problems in British Guiana, British Honduras and the British West Indies," by Mr. G. Howard Humphreys, M.I.C.E., and "Anti-Malarial Swamp Drainage in Lagos," by Mr. A. McDonald, M.I.C.E. Visits will be made during the week to laboratories and to works of civil engineering interest in and around London, and on Friday afternoon, July 23rd, at 3 p.m., Professor George Macdonald will deliver a lecture on "Tropical Hygiene as it Affects the Colonial Engineer." An official reception at the Institution of Civil Engineers on Friday evening, July 23rd, will conclude the proceedings of the conference.

A Scientific Information Conference

THE Royal Society is organising a Commonwealth conference on the Distribution of Scientific Information, which is to be held in London from June 21st to July 2nd. It will be recalled that the Royal Society Empire Scientific Conference of 1946 recommended that there should be convened at an early date a conference of libraries, societies and institutions responsible for publishing, abstracting and information services for the purpose of examining the possibility of improving existing methods of collection, indexing and distribution of scientific literature. The forthcoming, conference is the result of that recommendation and it will consider all scientific subjects, including engineering sciences, agricultural sciences, and medical sciences, but not social sciences. The subjects for discussion have been grouped into four sections, dealing with Publication and Distribution of Papers Reporting Original Work; Abstracting Services; Indexing and other Library Services; and Reviews, Annual Reports, &c. The conference will open in full session at the Royal Institution, Albemarle Street, London, W.1, at 11.30 a.m. on June 21st, and, subsequently, sectional plenary sessions will be held from which working parties will be appointed to prepare recommendations relating to the various subjects to be studied. At the final session of the full conference on July 2nd, approval will be given to the form of recommendations to be submitted to the Council of the Royal Society. A programme of social functions and visits, in which the delegates are asked to participate, has been arranged, and an exhibition illustrating certain aspects of the subjects under discussion will be open from June 21st to 30th in the rooms of the Royal Society, Burlington House, Piccadilly, W.1. The Conference Lecture will deal with "The Presentation of Scientific Information," and will be delivered by Professor E. N. da C. Andrade, F.R.S., in the hall of the Royal Institution on June 23rd at 2.30 p.m.

Town and Country Planning Committee

A COMMITTEE appointed by Mr. Lewis Silkin, the Minister of Town and Country Planning, and Mr. Arthur Woodburn, the Secretary of State for Scotland, under the chairmanship of Sir George Schuster, is to examine the qualifications needed by town planners. The terms of reference are as follow :—"To take account of the present and prospective scope of town and country planning, and to consider and report what qualifications are necessary, or desirable, for persons engaged in it, and to make any recommendations affecting such persons which appear to the committee to be relevant." It is understood that not only the newer aspects of town planning will be dealt with, but the spheres of architecture, engineering and surveying, which during the past thirty years have been ably co-ordinated by the Town Planning Institute, will also be examined. The members of the new committee are Sir George Schuster, member of the Government's Committee on Industrial Productivity, chairman; Sir Gerald Barry, Director-General of the Festival of Britain; Dr. Leonard T. H. Gray, chairman and managing director of Miller and Co., Ltd., Edinburgh, and Director of Edinburgh Chamber of Commerce; Mr. W. O. Hart, general manager of Hemel Hempstead New Town Development Corporation; Dr. R. M. Jackson, chairman of the Planning Committee, Cambridge County Council; Alderman Byng Kenrick, of Birmingham; Councillor Thomas Paterson, chairman of the Education Committee, Ayr County Council; Miss E. A. Sharp, Deputy Secretary the Ministry of Town and Country Planning, and Sir Robert Wood, Principal of University College, Southampton. The secretary of the committee will be Mr. H. R. Pollitzer, of the Ministry of Town and Country Planning. It is stated by the Ministers that the passing of the recent English and Scottish Planning Acts has placed much greater responsibility on planners. They have therefore decided that the successful working of the new legislation necessitates a re-examination of both the planners' field of action and of the qualifications desired of them.

The Late Monsieur Louis Lumiere

NEWS has been received from France that the death occurred on Sunday last, June 6th, at his home, "Villa Lumen," at Cote d'Azur, France, of Monsieur Louis Lumière at the age of eighty-three. Monsieur Lumière will long be remembered for his scientific work in collaboration with his brother, Auguste, on colour photography, and his contributions to photographic technique. He was the inventor of the Lumière system of direct colour photography, and he introduced the cinema in about 1896, and developed the stereo-synchronous principle of photography. He also invented an acoustic diffuser which was widely used. He was the founder of the Lumière Photographic Plate Company and played a leading part in perfecting the Lumière process for direct colour photography. For many years he was a member of the Institut de France, and was connected with other French scientific societies. His work was recognised by the bestowal of the Grand Cross of the Legion of Honour. His work was well known among the scientific and photographic societies of the world, and the articles and papers by himself and others who collaborated with him include valuable technical contributions to the science and technique of photography and other subjects which he made his own.

D.E.U.A. Summer Meeting

A LARGE number of members and guests of the Diesel Engine Users Association took part in the annual summer meeting on Tuesday, June 8th, when a visit was arranged to the London County Council's Main Drainage, Southern Outfall, pumping station at Cross Ness, Kent. The party travelled by water in the Thames steamer, "Ich Dien," and on arrival the party, which travelled under the leadership of Mr. W. Howes, President, and Mr. Hamish Ferguson, secretary, was received by Mr. A. V. Bayliss, the superintendent, and Mr. James Littlejohn, the deputy superintendent of the station. The high and low-level inlet mains and the screening and settling arrangements were inspected, and considerable historical interest was displayed in the old Watt beam pumping engines of 1865, and the later triple-expansion steam engines and pumps by Fleming and Ferguson, Ltd., of Paisley, installed in 1898. These plants will, we understand, be dismantled to make room for modern oil engine-driven pumps. In the other engine-rooms, the four sets of triple-expansion Fullerton Hodgart and Barclay engines driving Boving centrifugal pumps, and the four sets of Brush *vis-à-vis* six-cylinder oil engines driving 38in mixed-flow Mirrlees Watson centrifugal pumps installed in 1942, were seen in operation. Further engines included the Crossley Brothers 300 b.h.p., three-cylinder oil engines driving Harland Engineering 150-kW alternators, and the 150 b.h.p., three-cylinder Crossley Brothers engines driving Lilleshall sludge-loading pumps. The party returned to Westminster Pier in the early evening, after spending a very enjoyable day.

Mineral Development in Northern Ireland

AN arrangement to drill two deep bores and extend an existing shallow bore in the area east of Coalisland, Northern Ireland, has been entered into between the Ministry of Commerce for Northern Ireland and Richardson Timmins and Co., of Bletchley. This work forms part of an exploratory programme for mineral development which the Northern Ireland Government is undertaking, which has been planned by the Geological Survey for Northern Ireland. The resumption of the Survey as a permanent service in Northern Ireland began in April, 1947, and the remapping of the geology of Northern Ireland has commenced in the Coalisland area, which is believed to be the most promising coal-bearing area. The boring programme, of which the contracts referred to constitute the first stage, is designed to explore the geology of the region between Coalisland and Lough Neagh, where there is probably an extensive hidden coalfield. At the same time, it is realised that the exact geology of this area is largely unknown, and the possible economic value of its mineral resources can only be assessed by boring. On the results of the preliminary bores, which are expected to start in June or July, 1948, and to take a year to complete, will depend mainly the shape of the future programme of exploration in that area. The Survey is not concerned merely with the proving of coal, in which commercial firms are also interested, but in pursuing its normal programme of geological research, which should be greatly assisted by the borings to be undertaken by the Government.

Historic Researches*

No. XXXIII—X-RAYS

Wilhelm Konrad von Röntgen, 1845–1923, was born at Lennep, Westphalia, and began his scientific education at the Apeldoorn (Holland) Technical High School. Later he continued his studies under Clausius at Zürich, where he took his doctor's degree in 1869. At the age of twenty-five he was appointed an assistant in the physics laboratory at Würzburg University. Thereafter he held a similar post at Strasburg University. In 1875, he became Professor of Mathematics and Physics at the Agricultural Academy, Hohenheim, and in the following year returned to Strasburg in the same capacity. Next he was elected Professor of Physics and Director of the Physical Institute at Giessen, and in 1885 was appointed to a similar chair at Würzburg. It was in his laboratory at that university that in 1895, while experimenting on the conduction of electricity through gases, he discovered the rays with which his name is now associated. At first, he was inclined to believe that the rays were a form of light in which the vibrations in the ether were longitudinal instead of transverse, as in ordinary light. As, however, there was some doubt in his mind on this point, he decided to call them, non-committally, X-rays. For this discovery he received the Royal Society's Rumford Medal in 1896, and in 1901 the Nobel Prize in Physics. Röntgen also carried out a number of researches on light, heat, elasticity and electricity, but none of his work in these fields approached in importance his discovery of X-rays. He died at Munich in February, 1923, aged seventy-eight.

IN 1895 Wilhelm von Röntgen, like many other physicists in various countries, was engaged upon a study of the cathode rays emitted from highly evacuated discharge tubes when high voltages were applied to them. Using an ordinary discharge tube, he was paying particular attention to the fluorescence of the glass walls, a phenomenon which, although at that date far from being understood, had been clearly recognised as one possessing fundamental significance.

In the course of his studies Röntgen was surprised to find that some crystals of barium platino-cyanide, $BaPt(CN)_4$, in accidental proximity to the tube while it was running, were fluorescing brightly. When the tube was wrapped in black paper a screen coated

RONTGEN'S ORIGINAL TUBE

with the same substance and lying at a distance of several feet from the tube exhibited the same bright fluorescence. Röntgen quickly satisfied himself that the fluorescence was not caused by the incidence of either ordinary light or ultra-violet light on the screen.

Placing a metallic object between the tube and the screen, he found that it cast a shadow on the screen. Projecting straight lines from the edges of the shadow to the edges of the object and carrying them on, he observed that the lines came to a point on the tube on which the cathode rays were concentrated. Röntgen therefore concluded that a highly evacuated discharge tube in the fluorescent state gave out some hitherto unknown form of ray which was capable of penetrating atmospheric air to a very considerable distance, but which was stopped, or at least incommoded, by metallic bodies.

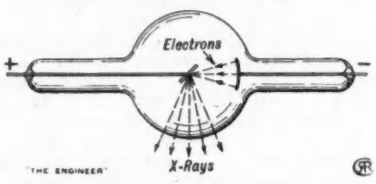
He next rapidly passed on to study the extent to which these mysterious X-rays, as he called them, were stopped, or permitted to pass, by bodies of different substance. He soon discovered that the penetrability of any substance was governed by the density of the substance and by its thickness. Then came the culminating discovery that the bones of the human body, being denser than the surrounding flesh, cast a shadow on a screen and that the rays, being photographically active, could impress an outline image of the bones on a photographic plate.

One must feel surprised at the fact that Röntgen's great discovery was not made at a much earlier date. Nothing contributing to it was new or unfamiliar to physicists. For fifteen or twenty years they had been playing with highly evacuated discharge tubes which all the time were emitting X-rays without their being aware of that fact. It is almost unbelievable that no one before Röntgen observed that some bodies or substances lying near the tube when in action exhibited fluorescence. Many acute minds were studying the multifarious phenomena accompanying the discharge of electricity through gases. Yet the significance of one of the most striking lay unrecognised until Röntgen explored it.

Within a few months of Röntgen's discovery it was receiving practical application in hospitals. Its physical implications, however, remained obscure. The same problem as the cathode rays presented again arose: were the X-rays composed of particles of matter or were they waves in the ether after the nature of light? Experimental evidence seemed to favour neither view. It was soon found that, unlike cathode rays, X-rays could not be deflected by a magnetic field. Hence, if they were composed of particles, those particles could not have electrical charges associated with them. On the other hand, if the rays were waves in the ether, they appeared to lack the characteristic properties of such waves, as represented by visible light. Experiment with the best available methods showed, or seemed to show, that X-rays were not reflected from a polished surface and that they were not refracted when passed through a prism. Further, the most closely ruled diffraction grating failed to reveal the phenomenon of interference. It was therefore impracticable to support the ether wave theory of X-rays by a determination of their wavelength.

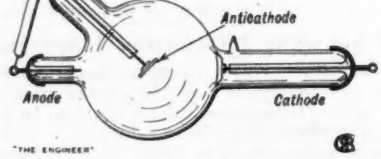
In 1897 Sir George Stokes advanced theoretical views which strongly suggested the possibility that X-rays were of a wave-like nature. He based his argument on a theoretical study of the effects produced when a moving particle of matter carrying an electric charge was suddenly stopped by encountering an obstacle. His deduction was that an electric and magnetic disturbance would spread outwards from the stopped particle with the velocity of light. This disturbance, it would seem, constituted an X-ray.

According to this theory, X-rays were produced when the cathode ray particles carrying negative charges had their motion stopped by encountering the glass walls of the discharge tube. The theory further implied that only a small fraction of the energy possessed by the cathode ray particles before they were stopped would be radiated as X-rays. The remainder would be converted into heat. These considerations quickly led to the design of discharge tubes particularly adapted to the emission of X-rays. In an early pattern of such a tube the cathode was made concave in order to concentrate the



EARLY FORM OF X-RAY TUBE

stream of particles at a point ahead of it. The particles were not allowed to reach the glass walls of the tube before being stopped. They were brought to rest against the surface of the anode, which was made in the form of a target situated at the point of concentration of the cathode particles. In this way the X-rays were caused to originate at a localised spot on the target instead of from the whole surface of the glass tube. They radiated in all directions from this spot and had no difficulty in passing through the glass walls. In a later type of X-ray tube the target was mounted on what was called an



X-RAY TUBE WITH "ANTI-CATHODE"

"anti-cathode," separate from, but electrically connected to the anode.

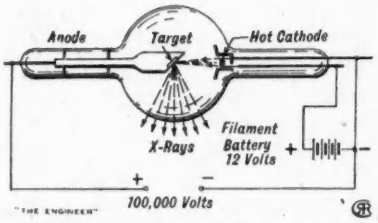
In these early X-ray tubes difficulty was encountered in making the target withstand the intense heat generated by the bombardment of the particles. This trouble was in part overcome by introducing arrangements for cooling the target and by using platinum, tungsten or other high-fusing point metal as the material of the target. The use of such heavy metals had an additional advantage. It was discovered that the proportion of the cathode ray energy radiated as X-rays increased with the atomic weight of the target material.

Yet another difficulty was met in the fact that after a tube had been in use for some time the residual gas within it became absorbed. As a consequence its pressure fell

* Nos. I, II and III on "Friction" appeared July 14, 21 and 28, 1944; Nos. IV, V and VI, on "The Mechanical Equivalent of Heat," appeared September 29, October 6 and 13, 1944; Nos. VII, VIII and IX, on "Electro-Dynamics," appeared March 9, 16 and 23, 1945; Nos. X, XI and XII, on "The Ether Drift Experiments," appeared August 3, 10 and 17, 1945; Nos. XIII and XIV, on "Specific, Latent and Atomic Heats," appeared December 7 and 14, 1945; Nos. XV, XVI, XVII and XVIII, on "Chemical Elements and Atoms," appeared August 2, 9, 16 and 23, 1946; Nos. XIX and XX, on "The Classification of the Elements," appeared September 27 and October 4, 1946; Nos. XXI, XXII, XXIII and XXIV, on "Molecular Physics," appeared March 28, April 4, 11 and 18, 1947; Nos. XXV, XXVI, XXVII and XXVIII, on "Conduction of Electricity Through Liquids," appeared October 24 and 31, November 7 and 14, 1947; Nos. XXIX, XXX, XXXI and XXXII, on "Conduction of Electricity Through Gases," appeared March 12, 19, 26, April 2, 1948.

and therefore the voltage across the terminals required to maintain the discharge had to be increased. In order to maintain the tube in steady working, arrangements had to be made for the periodical admission of fresh gas to the tube.

In 1913 the American physicist Coolidge developed a fundamentally different form of X-ray tube, the "hot cathode" tube. By that date it had been discovered that "cathode ray particles," or electrons, as they were now called, were not peculiarly the product of an electrical discharge through a highly rarefied gas. They were found to be emitted also from a metal or other body when it was highly heated. This fact permitted Coolidge to dispense entirely with the gas in a discharge tube and to pass the high-voltage discharge through the vacuum by means of a stream of electrons emitted from a metal filament rendered incandescent by a low-voltage current. The filament, generally of



COOLIDGE HOT CATHODE X-RAY TUBE

tungsten, was placed at the centre of a concave cathode. The electrons emitted by the filament were concentrated into a beam which fell upon a tungsten or molybdenum target embedded in a copper anode. A 12-V battery was sufficient to raise the filament to the electron-emitting stage. The voltage applied across the electrodes is to-day commonly obtained by means of a transformer followed by a rectifier and may be anything from 100,000V upwards, according to the use to which the rays are to be put.

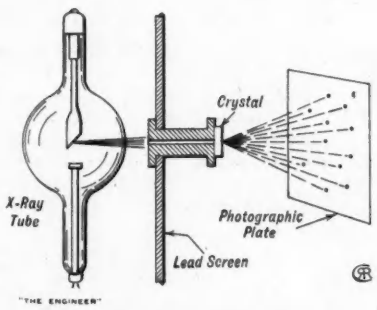
At an early stage in the development of the X-ray tube it was discovered that the depth to which the rays penetrated into any given material increased with the voltage applied across the electrodes. The interpretation of this fact remained obscure until the mystery regarding the fundamental nature of the rays was resolved. Were they corpuscles or were they waves of what might be called invisible light? If they were corpuscular, what was the explanation of the increased penetration accompanying higher voltage? It seemed as if the particles produced at high voltage must either be smaller in size or endowed with greater energy than particles produced at low voltage. On the other hand, if the rays were waves it was conceivable that the wavelength might be dependent upon the applied voltage, decreasing as the voltage was increased. This supposition made it fairly easy to understand the variation of the penetration with the voltage. Against the wave theory, however, was the experimental fact that with the finest diffraction gratings available the rays showed no sign of interference as they should have done if they were waves of invisible light.

Stokes' theoretical study of the subject furnished a possible explanation of the problem. It suggested that the rays were waves of very short wavelength and that the apparent absence of interference effects was to be traced to the lack of diffraction gratings of sufficiently fine ruling.

In one form a diffraction grating consists of a plain glass plate, on one face of which a series of parallel lines is ruled at close uniform intervals. The lines form barriers to the passage of light through the glass. The spaces between the lines constitute a multiplicity of windows. These windows serve the same fundamental purpose as the two slits in the screen used by Dr. Thomas Young in 1801 to demonstrate the phenomenon of interference in the case of visible light and to measure its wavelength.† In a more widely used form the grating acts, not by transmitting the light, but by reflecting it. In this form the lines are ruled on the surface of a metallic mirror, which may be plain, but is generally made concave to facilitate the focusing of the interference "fringes."

In order to obtain satisfactory results the lines of a transmission or reflection grating must be spaced apart at a distance which is not excessively great relatively to the wavelength of the light under examination. For example, to measure the wavelength of yellow light—about 0·00006cm—a grating with 7000 lines to the centimetre could be used—that is, one with the lines spaced 0·000143cm apart. Knowing, as we now do, the very small order of the wavelength of X-rays, we can say that, in the same proportion, a grating with several million lines per centimetre would have been required to demonstrate the interference of the rays and thereby to establish their undulatory nature and measure their wavelength. Gratings approaching anything like this fineness of ruling were not available during the last decade of the nineteenth century. Even to-day gratings with more than 20,000 lines per centimetre are exceptional.

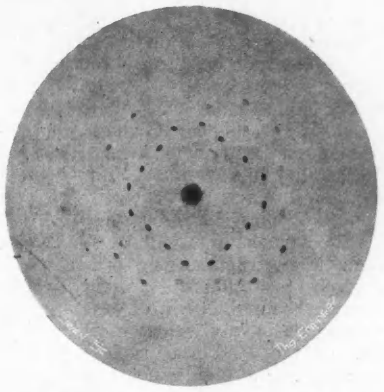
The problem thus presented remained unsolved until 1912. In that year Professor Max von Laue, of Zürich University, conceived the idea that the wavelength of X-rays might be of the same order of magnitude as the spacing of the atoms in a crystalline body. If that proved to be true, then it ought to be possible to use a crystal as a diffraction grating possessing a fineness of ruling far beyond the limit of mechanical production. With the assistance of Friedrich and Knipping, Laue set up a photographic plate in front of a crystal of zinc sulphide,



LAUE'S EXPERIMENT

through which there was passed a beam of X-rays rendered narrow by means of a fine-bore lead tube at the centre of a lead screen. When the plate was developed there appeared on it a symmetrical grouping of small black spots surrounding a large central spot. It was found that different crystalline substances produced characteristic spot patterns.

The interpretation of the patterns was not an easy task. The large central spot, common to all photographs, could be ignored. It was formed by those rays which passed through the crystal without encountering any of the atoms and could conveniently be masked by means of a small lead disc placed between the crystal and the plate. The surrounding rings of dots, it was realised, revealed the structure of the crystal. They were formed by the reflection or diffraction of the rays which encountered the atoms and the symmetry of their distribution was a visible sign of the regularity of disposition of the atoms within the crystal. The key to the full quantitative interpretation was found when the photographs were regarded as patterns produced by a diffraction grating differing from the ordinary grating in so far that instead of



LAUE DIFFRACTION PATTERN FROM ZINC SULPHIDE

being two-dimensional, it was three-dimensional. Chief among those who elucidated the physical significance of the Laue radiographs were Sir William Bragg and his son, Sir Lawrence Bragg.

The developments which followed upon Laue's discovery in 1912 were rapid and momentous. In addition to opening up a way to the study of crystalline structure, Laue placed in the hands of physicists a means of determining the wavelength of X-rays and, with that fundamental knowledge in their possession, of passing on to explore many new and strange fields. Here it must suffice to record that the wavelength of X-rays—even those emitted at one and the same time by one and the same tube—was eventually found to cover a wide range of values. The X-ray band of the electromagnetic spectrum is now known to have a width many times as great as that of the visible light band. The "hardest" X-rays—those with the shortest wavelength and the greatest penetrating power—have wavelengths as short as 0·03 of an Angstrom unit.‡ The "softest" rays—those with the longest wavelength and the least penetrating power—have wavelengths of about 1000 Angstrom units.

In the electromagnetic spectrum the X-ray band at its upper end merges into the extreme ultra-violet wavelengths. At its lower end it merges into the wavelengths of the gamma rays emitted spontaneously during the disintegration of radioactive substances. There is no overlapping of these bands and no defined demarcation between them. The electromagnetic spectrum from the shortest gamma rays, through X-rays, ultra-violet rays, rays of visible light, infra-red rays, heat rays, to the longest wireless rays, is continuous. The only fundamental difference between these various rays lies in their wavelengths. They may all be described quite correctly as X-rays or, if we like, as light rays. More precisely they are all electromagnetic waves. The fact that some of them are produced in one way and some in another, does not justify any division of them into sharply defined fundamentally different classes. Nor does the fact that they produce widely different effects when they encounter material substances—including the

† See Article No. X of this series, published in the issue of August 3, 1945.

‡ One Angstrom unit = 0·00000001cm.

matter of the human eye—imply that they differ in any categorical respect other than that of their wavelengths.

To-day, physicists are no longer entirely dependent upon the use of crystals for the measurement of X-ray wavelengths. In 1925 the French physicist Thibaud and the American physicists Compton and Doan separately evolved a method of using a diffraction grating for the purpose. The principle employed consisted of allowing a pencil of X-rays to fall at a very small angle of incidence on a reflection grating ruled with from 500 to 2000 lines to the centimetre. If the angle of incidence is of the order of three or four minutes the effect produced is the same as if a grating of exceedingly fine ruling were used in the normal manner. The wavelengths determined in this direct manner were found to agree satisfactorily with those deduced from crystal radiographs.

Although the portion of the electromagnetic spectrum assigned to X-rays cannot be given precise limits, it is roughly true to say that the middle point of the X-ray range corresponds to a wavelength which is only one-thousandth of the wavelength corresponding to the middle point of the visible light range. It is, as we have said, only in their relative shortness of wavelength that X-rays differ from visible light rays. It was the shortness of their wavelengths which made them at first appear to lack the essential characteristics commonly associated with light. Not only can they be made to exhibit the phenomenon of interference; it has now been found that they can also be reflected, refracted and polarised, but on a scale which renders the detection of their behaviour in these respects much more difficult than in the case of visible light.

The shortness of their wavelengths explains one of their most important physical effects, their ability to render a gas exposed to them electrically conductive. Ordinary light lacks this property, but as the ultra-violet region is approached signs of it are noticed. Going further down the wavelength scale into the X-ray region, the property becomes increasingly well-marked until a stage is reached at which a gas at ordinary pressure will while irradiated by "hard" X-rays conduct electricity under a pressure of a few volts. The conductivity, it is found, does not reach its full value immediately the irradiation is begun. Further, it persists, in a diminishing degree, for a short time after the irradiation is stopped.

The explanation of the conductivity imparted to a gas by its exposure to X-rays is to be found in the fact that the wavelength of "hard" X-rays is of an order comparable with atomic dimensions. When the rays are passed into a gas some of them encounter the gaseous atoms and by their impact detach electrons from the atoms which they strike. The electrons so set free act as negative ions either by themselves or after uniting with other of the gaseous atoms which have escaped disruption. The residues of the disrupted atoms constitute positive ions. In this way the gas is ionised. If an electrical potential is now applied to the gas the negative ions will be driven or pulled towards the anode and the positive ions towards the cathode and, carrying their charges with them, will constitute a flow of electricity through the gas.

Not all the electrons liberated by the primary irradiation succeed in reaching the anode. Some of them collide with undisrupted atoms and are brought to a stop. In accordance with Stokes' theory their stoppage results in the emission of X-rays. These secondary X-rays—or "characteristic" rays, as they are called, since their wavelength is determined by the particular character of the gas—produce in turn further ionisation of the gaseous atoms. The conductivity of the gas in this way takes time to build up to its full value. It dies away gradually after the primary irradiation has been stopped, because the free electrons existing in the gas at the moment of stopping are still capable of causing the emission of secondary X-rays. The gas will remain conductive to a diminishing degree until all the electrons formed by the secondary rays have reached the anode.

That there should be a limit to the conductivity imparted to a gas by X-ray irradiation can readily be understood. The electrons themselves form a barrier to the penetration of the gas by the primary rays. A ray encountering an electron cannot set free an electron, as it may do if it strikes an atom. Such a ray becomes scattered, reflected or absorbed. Hence the ionisation initiated by the primary irradiation may be said to be self-destructive. The conductivity will increase to a point of saturation at which the production of electrons is balanced by the capacity of the electrons to stop the penetration of the gas by the rays. Applied to solid bodies, this argument explains why a substance such as lead containing many electrons in its atom presents a more effective barrier to penetration by X-rays than a substance such as aluminium containing few electrons within its atom.

Here we touch the fringe of a vast new branch of modern physics. The behaviour of different substances—solid, liquid and gaseous—towards X-rays has provided physicists with a means of entering upon paths which have already led them to penetrate some of the innermost secrets of the atom. That story must, however, wait awhile. We can here only mention the nature of one of its earliest and most striking chapters.

The wavelengths of the X-rays emitted by a tube are characteristic of the element used as the anti-cathode or target against which the electrons of the cathode rays are brought to rest. The X-rays so emitted are amenable to spectrum analysis in the same general manner as are visible light rays. In 1913 H. G. Moseley discovered that the chemical elements taken in the order of their atomic weights gave X-ray spectra, the lines of which, from one element to the next, showed regular step-by-step shifts of position. The implication was that the characteristic wavelengths of the rays emitted by the elements formed a graduated series and that they revealed the number of electrons within the respective atoms. Each shift of the spectrum lines implied an increase of one in the number of electrons in the atom of the element concerned relatively to that in the atom of the element next below it in order of atomic weight.

The chief mystery of the periodic classification of the elements was thus solved in a remarkable and beautiful manner. Mendeléef and his fellow-workers would certainly have been surprised if they had been told that the numbers corresponding to the order of succession of the elements in their tables—1 for hydrogen, 2 for helium, 3 for lithium, 4 for beryllium and so on—were not simply numerical labels, but had a profound physical significance. They are the actual numbers of the electrons which the atoms contain. They, and not the atomic weights, offer the main clue to the unravelling of the great problem presented by the periodic recurrence of similar chemical and physical properties among the elements.

Remarkable Freight Locomotives: Pennsylvania Railroad

By E. C. POULTNEY, M.Inst.Loco.E.

No. III—(*Continued from page 537, June 4th*)

BOILER PERFORMANCE—EVAPORATIONS

THE firing rates based on the dry coal pounds per square feet of grate area per hour, also the actual net evaporations and the equivalent evaporations, are given by Table VI. The net evaporation is made up of the feed delivered to the heater by the cold water pump, and the exhaust steam from the engine cylinders condensed by the heater and returned in the form of hot feed to the boiler. The exhaust steam condensed varied from 5087 lb to 13,540 lb per hour when the cold feed delivered to the heater was 65,906 lb and 106,332 lb per hour. These are the minimum and maximum amount of exhaust steam delivered to the heater tests 1740 and 1749. The net evaporations being 70,993 lb and 137,479 lb seem to indicate that the exhaust steam condensed from the engine cylinders is from 7·1 to about 9·8 per cent of the total net evaporation. The equivalent evapora-

TABLE VI.—*Boiler Performance; Firing Rate and Evaporation*

Test No.	Dry coal-fired		Net water evaporated		Equivalent evaporation		
	Per hour	Per sq ft of grate area per hour	Per hr-lb	Per lb of coal-fired, lb	Per hour	Per lb of coal-fired, lb	Per sq ft of heat surface
			Without Induction Tubes				
1730	10,971	90·1	71,909	6·59	87,729	8·0	9·0
1751	10,991	90·4	75,362	6·84	92,275	8·4	9·4
1731	13,414	110·2	86,581	6·08	106,006	7·9	10·8
1750	13,926	114·4	89,455	6·42	110,089	7·9	11·2
1729	23,018	189·1	131,351	5·70	162,816	7·1	16·6
1735	19,057	156·6	109,587	5·74	135,470	7·1	13·8
			With Induction Tubes				
1740	10,159	83·5	70,993	6·99	86,805	8·5	8·9
1755	11,822	97·1	74,206	6·27	90,859	7·7	9·3
1739	13,914	114·3	88,800	6·37	108,878	7·8	11·1
1760	14,524	119·3	90,614	6·22	111,725	7·7	11·4
1741	19,221	157·9	100,365	5·74	136,312	7·1	13·9

tions per square foot of heating surface are based on the total heating surface of 9797 square feet.

The net evaporation plotted against the rate of firing dry coal per square foot of grate area per hour is shown by Fig. 8. The plotted points refer to the results with and without the induction tubes, but a single curve as shown appears to be representative of all the tests.

Boiler Performance—Steam Supply

The purpose of the boiler is to supply superheated steam to the engines, and Table VII shows the weight of steam supplied to the superheater per hour, together with the steam pressures and temperatures recorded in the steam pipe between the superheater and the steam chests. The degree of superheat in the steam is also given, all the results being shown for different engine running conditions, as indicated by the speed in r.p.m. and the nominal cut-offs. As the rate of steam flow increases the pressure loss through the superheater and throttle valves also increase while the steam temperatures recorded are also augmented.

Considering the very high rates of steam flow, which reach as much as 134,000 lb per hour, the pressure loss at this high rate of working of only 11 lb per square inch may be taken as very reasonable.

Steam temperatures vary with the rate of evaporation and steam flow to the engines, and ranged from 656 deg. to 746 deg. Fah., corresponding to superheats of from 237 deg. to 330 deg. Fah.

For these tests 1730 and 1746 the steam pipe pressures are 291 lb and 282 lb per square inch, and the heat in the steam supplied per i.h.p. and the weight of steam required per i.h.p.-hour are for these tests 19,637 B.Th.U. and 14·6 lb and 22,009 B.Th.U. and 15·8 lb. The B.Th.U. per lb of steam are therefore 1340 and 1390, respectively.

Although there is a fall in the actual steam pressure at the cylinders, the increased temperature increases the heat content of the steam delivered to the engines. The heat supplied to the cylinders per i.h.p. developed is not included in Table IX, which gives the coal and water rates per i.h.p.-hour.

Engine Performance

The class "Q 2" engines have their reciprocating masses balanced to the extent of 28·3 per cent. To protect the test plant, it was found that this amount of overbalance should be increased to 50·5 per cent, thus reducing the underbalance to 49·5 per cent. Even with this additional overbalance it was found that at speeds of 200 r.p.m. or less the longitudinal forces set up resulted in a large amplitude of movement when the front and rear engines were in phase. In consequence of this most tests were carried out at speeds in excess of 200 r.p.m. and none was made at speeds below 160 r.p.m. A portion of the dynamometer records showing the amplitude of the longitudinal force when the front and rear engine units are in phase and in opposite phase is shown by Fig. 9.

It will be observed that speed has a considerable influence on the variations in the longitudinal forces. The marked effect on these forces when the engine units are in phase at low speed will be noticed. This is, however, so much reduced at the higher speed of 280 r.p.m. that it appears no greater than that shown when the two sets of engines are in opposite phase at the lower speed of 160 r.p.m.

As a result of a discussion on this graph, Mr. Cover makes, in part, the following remarks:—

"With an engine such as the 'Q 2' it is found that in road service the front and rear engines go in and out of phase at regular intervals, depending, apparently, upon the slight difference in diameters of the two sets of driving wheels, which in effect are tied together by the rail. On the test plant the conditions are different. It is possible to run the front set of driving wheels at 20 m.p.h. and the rear set at 40 m.p.h. The operators who control the speed endeavour to keep the two engines at the same speed, but they cannot do this exactly, with the result that at irregular intervals they become in phase and then gradually out of phase. The records shown by Fig. 9 were continuous records run long enough to show this in and out of phase condition."

Table VII.—*Boiler Performance; Steam Supply to Engine*

Test No.	Test designation	Steam to superheater, lb per hour	Steam pressures		Steam temperatures, Deg. Fah.	
			Boiler	Steam pipes	Total	Superheat
		Without Induction Tubes				
1730	200—25—F	69,382	295	291	656	237
1751	200—25—F	72,605	293	289	665	246
1731	240—30—F	83,944	294	290	686	267
1750	240—30—F	86,597	294	289	694	275
1729	280—40—F	128,108	294	286	732	315
1735	280—35—F	106,558	294	284	721	304
		With Induction Tubes				
1740	200—25—F	68,770	293	290	656	238
1755	200—25—F	71,871	296	292	663	244
1739	240—30—F	86,137	298	288	687	269
1760	240—30—F	87,674	296	292	694	275
1741	280—35—F	107,222	293	285	720	303

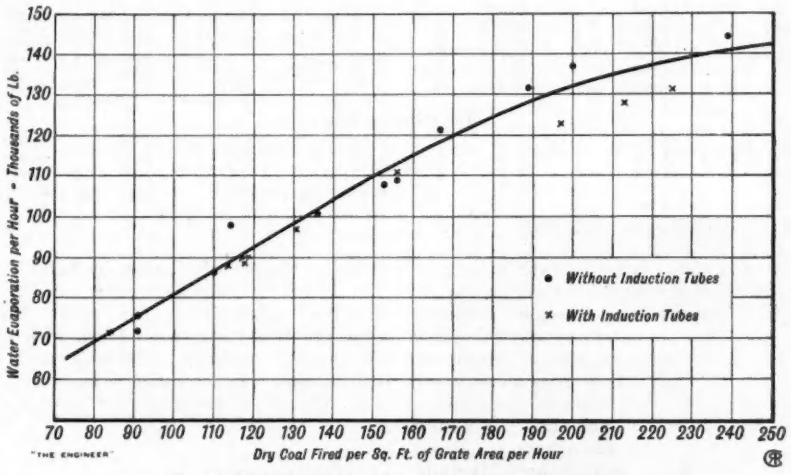


Fig. 8—Net Evaporation and Rate of Firing

Steam Flow—Pressure Loss

The steam from the superheater to the rear cylinders must pass through steam pipes approximately 18ft longer than those leading to the front cylinders. In consequence there is a rather higher pressure loss at the rear engine steam chests. The loss in steam pressure is dependent upon the rate of steam flow; it therefore increases with an increase in speed for any given rate of cut-off or at any stated speed with an increase in the rate of cut-off.

Table VIII.—*Engine Performance; Running Conditions and Steam Pressures*

Test No.	Test designation	Front Engine				Rear Engine			
		M.e.p.	Cut-off, per cent	Steam chest pressure	Least back pressure	M.e.p.	Cut-off, per cent	Steam chest pressure	Least back pressure
		Without Induction Tubes							
1730	200—25—F	127·5	29	300	8	101·5	25	299	8
1751	200—25—F	128·9	27	294	8	106·3	25	300	7
1731	240—30—F	131·5	30	300	13	106·3	34	296	12
1750	240—30—F	131·7	34	293	14	110·7	30	297	13
1729	280—40—F	149·8	44	297	25	124·8	42	296	20
1735	280—35—F	139·7	38	298	20	112·1	36	296	20
		With Induction Tubes							
1740	200—25—F	126·3	28	300	7	105·2	26	297	7
1755	200—25—F	131·0	29	297	9	108·2	26	303	8
1739	240—30—F	130·6	34	301	13	111·4	32	294	12
1760	240—30—F	134·7	35	297	14	111·4	31	302	14
1741	280—35—F	136·9	38	294	21	114·6	36	297	21

Some examples representative of the relation between steam flow and pressure drop at the front and rear engine cylinders are as given below:—

Test	Speed	Cut-off	Steam Flow	Pressure Loss Front	Rear
1730	200	25	69,382	3·7	4·0
1732	200	40	89,952	6·9	7·4
1731	240	30	83,944	4·8	5·2
1728	240	42	118,519	9·0	9·9
1729	280	40	128,108	10·3	11·3

The cut-offs are the nominal rates of admission. The steam flow is in pounds of

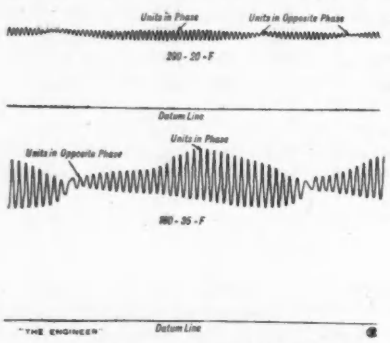


FIG. 9—DYNAMOMETER RECORD OF LONGITUDINAL FORCES

steam per hour, and the pressure losses are the steam pressures/lb per square inch. All tests were run with the throttle or regulator fully open.

ENGINE RUNNING CONDITIONS

Particulars relating to the engine running conditions are given by Table VIII. The mean effective pressures as between the front and rear engines show in some instances considerable variations. The cut-offs given are those shown by the indicator diagrams. For reasonably similar rates of actual cut-off the mean effective pressures realised in the cylinders for the front engine are higher than those in the cylinders for the hind engine. The difference in the steam pressures between the front and rear engines is stated to be due to two fundamental causes. These are :—

First, the kinetic behaviour of the steam in the long steam pipe produces a fluctuating steam chest pressure. The pressure waves are synchronised with the valve movement and so timed as to be at a minimum when the rear valves start to open. Since the weight of a cubic foot of steam is proportional to the absolute pressure, steam at 300 lb is heavier and therefore produces greater inertia effect in pulsating movement than steam at lower pressures. It seems likely that the pressure waves have a natural period and therefore their effect is greater at certain locomotive speeds than others.

Secondly, the valves of the rear engine have a diameter of 14in, 2in more than those of the front engine. This is an increase of only 17 per cent, and therefore the valves of the rear engine are relatively smaller than those of the front engine. This causes a greater pressure drop from steam chests to cylinders in the rear engine.

TABLE IX.—*Engine Performance ; Power Developed ; Coal and Water Consumptions*

Test No.	Front engine, i.h.p.	Rear engine, i.h.p.	Total i.h.p.	Coal, lb per i.h.p.-hr	Water, lb per i.h.p.-hr	Cylinder efficiency, per cent
			Without Induction Tubes			
1730	2161·6	2574·4	4,736	2·32	14·6	15·2
1751	2185·1	2698·5	4,884	2·25	14·9	14·2
1731	2673·7	3236·3	5,910	2·77	14·2	15·6
1750	2680·1	3373·1	6,053	2·30	14·3	15·4
1729	3554·8	4432·1	7,987	2·88	16·0	15·4
1735	3312·9	3978·9	7,292	2·61	14·6	15·1
			With Induction Tubes			
1740	2140·0	2733·9	4,874	2·08	14·1	15·7
1755	2221·3	2744·1	4,965	2·38	14·5	15·3
1739	2655·5	3291·9	6,047	2·30	14·2	15·5
1760	2738·0	3391·4	6,129	2·37	14·3	15·4
1741	3248·6	4071·1	7,320	2·63	14·6	15·1

Note.—Coal per i.h.p.-hr, based on dry coal. Water per i.h.p.-hr, cylinder feed only.

TABLE X.—*Locomotive Performance ; Drawbar Horsepower ; Coal and Water Rates*

Test No.	D.b.h.p.	Coal consumption			Water supply required per d.b.h.p.-hr-lb	Heat in coal B.Th.U. per d.b.h.p.-hr.
		Coal as fired per d.b.h.p.-hr.-lb	Dry coal per d.b.h.p.-hr.-lb	Coal as fired per mile, lb		
			Without Induction Tubes			
1730	4,016	2·87	2·73	281	16·5	38,742
1751	4,046	2·81	2·72	277	17·1	36,061
1731	5,021	2·76	2·67	282	15·9	38,215
1750	5,162	2·79	2·70	293	15·7	35,757
1729	6,782	3·54	3·39	418	17·4	47,277
1735	6,095	3·32	3·13	353	16·5	43,851
			With Induction Tubes			
1740	4,003	2·63	2·54	257	16·5	35,650
1755	4,172	2·93	2·83	298	16·4	36,854
1739	5,092	2·83	2·73	293	15·9	38,318
1760	5,225	2·91	2·78	310	15·6	36,067
1741	6,187	3·23	3·12	347	16·3	41,284

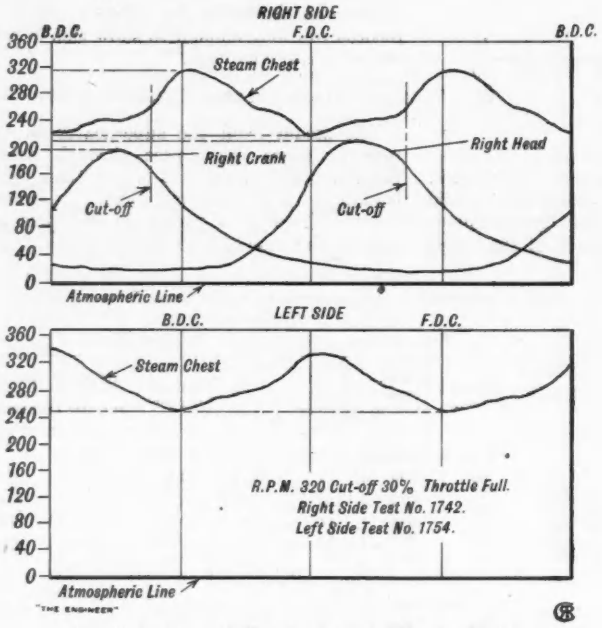


FIG. 10—INDICATOR DIAGRAMS FOR REAR ENGINE

STEAM CHEST PRESSURES

Some further remarks regarding steam chest pressure are of particular interest, as it is probable that they are to a greater or lesser extent applicable to all reciprocating engines. The drop in pressure between the boiler and the steam chests has already been noted. An examination of the indicator cards, and in particular steam chest diagrams, show that when the pistons are at the end of the stroke and the steam admission valves open, the drop in steam pressure is quite considerably in excess of the pressures shown by Table VIII.

In order to investigate more closely the pressure variations in the steam chests some indicator cards were taken with electro-magnetic pressure indicators, and the oscillograms make it easier than with ordinary diagrams to trace the relationship between the valve events and the pressures in the steam chests.

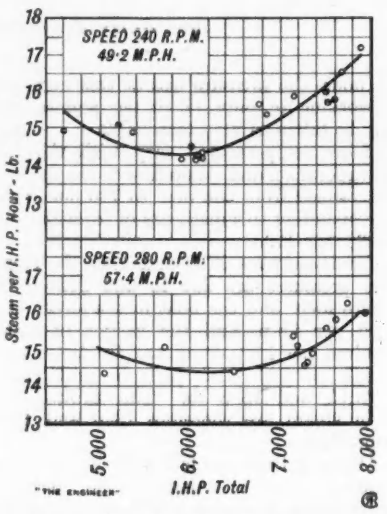


FIG. 11—STEAM RATE AND POWER DEVELOPED

Cards thus obtained taken from the rear engine cylinders are reproduced by Fig. 10. Concerning this the following observations are made :—

"It will be noted that while the steam chest pressure is at a minimum at the ends of the stroke when either the head end or

crank end admission port is open, nevertheless practically all of the decrease in steam chest pressure occurs after cut-off at one end of the cylinder and before admission at the other end; that is, when no steam is flowing into the cylinders on that side of the locomotive. Although the relationship is complex, it is evident that the inertia of the steam in the long steam pipes causes pressure waves resulting in a steam chest pressure during the admission period that is considerably below the average steam chest pressure measured by a mercury manometer. A large steam chest volume will undoubtedly reduce the inertia effect and raise the pressure during admission."

Indicator cards were not taken with the electro-magnetic pressure indicators for the front engines. It may, however, be remarked that the usual diagrams taken all show that the steam chest pressure fluctuations are much smaller than those at the rear engines.

Engine Performance : Powers Developed : Steam and Coal Rates

The powers developed in the cylinders of the front and rear engines and the total powers indicated are given in Table IX. The difference in the powers shown for the front and rear engines are not quite proportional to the relative cylinder dimensions. Actually the division of power as between the leading and hind engines should be in the relation of 40 and 60 per cent of the total power. That is, it should be in proportion to the number of driving wheels, of which there are four for the leading engine and six for the hind engine. Based on the tests made on the plant, the average power developed by the front engine was about 44 per cent, and by the rear engine 56 per cent of the total. The maximum power developed, test 1729, is 7987 i.h.p. at 280 r.p.m., 57·4 m.p.h., at cut-offs of 44 and 42 per cent for the front and rear engines. The steam rate is 16 lb per hour, cylinder feed only. When the total power developed was 7987 i.h.p., the powers indicated for the front and rear cylinders were as shown by Table IX—3554·8 i.h.p. and 4432·1 i.h.p., respectively, giving, therefore, a division of power of 44·5 and 55·5 per cent.

Table IX also gives the indicated thermal efficiency of the steam action in the cylinders, which, for twenty-two tests, varied from 13·3 to 15·6 per cent. This is based on the heat content of the superheated steam less that in the liquid at the pressure of the exhaust.

The steam rate is uniformly low, ranging, during twenty-two tests, between 14·1 lb to 16·7 lb per i.h.p.-hour, while the coal required per i.h.p.-hour varies from 2·08 lb to 3·58 lb.

Figure 11 shows the steam consumption by the cylinders per i.h.p. for the tests made at 240 r.p.m. and 280 r.p.m. plotted against the i.h.p. developed.

If it is assumed that the class "Q 2" locomotives normally operate at speeds of 200 r.p.m. to 240 r.p.m., equal to from 40 m.p.h. to 50 m.p.h., the steam rates would vary only between the limits of 14 lb and 15 lb per i.h.p.-hour and the coal required on the same basis would run from 2 lb to 3 lb.

Locomotive Performance : Horse-Powers : Fuel and Water Consumptions

The overall performance of the locomotive, that is the power developed at the drawbar, and the fuel and water consumptions per d.b.h.p.-hour are given by the concluding Table X. The water rates per d.b.h.p.-hour are based on the total water taken from the tender less losses at the safety valves.

The powers developed during twenty-two tests varied from 4016 d.b.h.p. to 6825 d.b.h.p., while the coal required on the basis of the coal "as fired" ranged from 2·63 lb to 4·5 lb per d.b.h.p.-hour. The heat units in the coal fired required per d.b.h.p. are from 35,650 B.Th.U. to a maximum of 58,563 B.Th.U. per d.b.h.p.-hour. The highest cylinder power recorded was 7898 i.h.p., test 1729, when the power at the drawbar was 6782 h.p., giving therefore a mechanical efficiency of practically 86 per cent.

The coal "as fired" is shown to be 3·54 lb per d.b.h.p.-hour, and at this speed—280 r.p.m., or 50 m.p.h.—the coal consumption per mile is 418 lb.

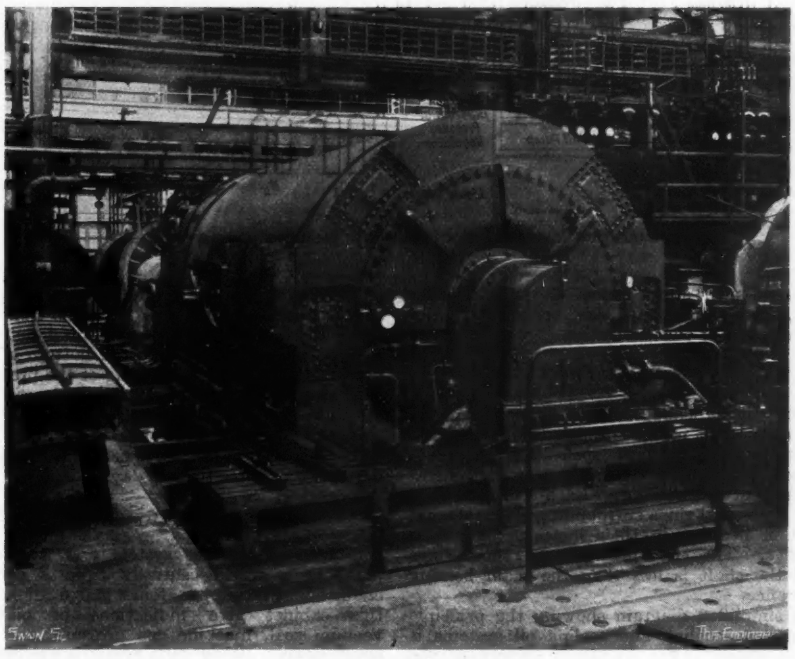
The thermal equivalent of one horse per hour is 2545 B.Th.U.; therefore, as the locomotive required 47,277 B.Th.U. per h.p.-hour, the overall efficiency is 5·4 per cent. The lowest heat consumption per d.b.h.p.-hour is 35,650 B.Th.U., test 1740, run at 200 r.p.m., and at a nominal cut-off of 25 per cent., the overall efficiency being 7·14 per cent. The coal "as fired" varies from 257 to 585 lb per mile.

Hydrogen-Cooled Alternator for Littlebrook "B" Power Station

LAST week we were given the opportunity of attending a demonstration run while the first hydrogen-cooled turbo-alternator for Littlebrook "B" power station was undergoing works tests at the Metropolitan Vickers Electrical Company, Ltd., Trafford Park. The completion of this machine is an event of some significance to the British electrical industry, for although a good deal of practical experience has been gained with hydrogen cooling in the U.S.A., the Littlebrook turbo-alternator is the first of its kind to be manufactured and tested in Great Britain.

Since hydrogen cooling, in practice, is new to this country, it is perhaps desirable to preface our brief description of the equipment with a short summary of the considerations which favour its use. In the first place the density of hydrogen is about one-fourteenth that of air; windage losses and noise are therefore greatly reduced, and the resulting increase in efficiency represents a useful gain in a large set. Because of its thermal properties, hydrogen has a number of advantages over air as a cooling medium. Its heat-carrying capacity is about fourteen times that of air, and its heat-transfer coefficient is 50 per cent higher, so that hydrogen absorbs heat from the alternator and discards it in the coolers more readily than air. Again, hydrogen has seven times the thermal conductivity of air and this fact results in reduced temperature gradients between adjacent parts of the machine. All these factors contribute towards reduced temperature rises for a given output, or conversely, an increased output from a given machine.

Hydrogen offers other advantages compared with air. The possibility of deterioration of insulation due to corona is almost eliminated in hydrogen. An incidental gain which partly offsets the additional complication associated with hydrogen cooling is that moisture and dirt are excluded by the complete sealing which is necessary in hydrogen-cooled machines. Finally, because hydrogen will not support combustion, fire cannot occur in a machine provided the hydrogen purity is maintained above 75 per cent.



ALTERNATOR ON TEST BED

The Alternator

The alternator, which will be installed in the Littlebrook "B" power station of the British Electricity Authority, is rated at 75,000kVA, 0·8 power factor, 11·8kV, 3000 r.p.m. In general the electrical windings and magnetic circuits are of conventional design and the main departures from orthodoxy, as elaborated below, concern the frame and shaft seals asso-

ciated with hydrogen cooling. The alternator has bracket-type bearings and (as illustrated herewith) the frame is made unusually strong to support the heavy brackets which carry the whole weight of the rotor (32 tons). Including its gas coolers, the stator weighs 151 tons.

Excitation is supplied from a separate motor driven exciter. The slip-rings carrying the excitation current to the rotor winding are mounted on the shaft outside the outboard bearing and are housed in a separate chamber, which is ventilated by air drawn from the engine-room through a filter in the base of the casing.

To cool the hydrogen, which is circulated inside the machine by conventional methods, as indicated by arrows in the accompanying diagram, four horizontal gas coolers are housed in the frame. Each of these coolers is a nest of finned, water-cooled tubes similar to the arrangement used for closed-circuit air-cooled alternators. To prevent any frame vibration from being transmitted to the cooler tubes, and at the same time to allow for differential expansion, the cooler assemblies are flexibly

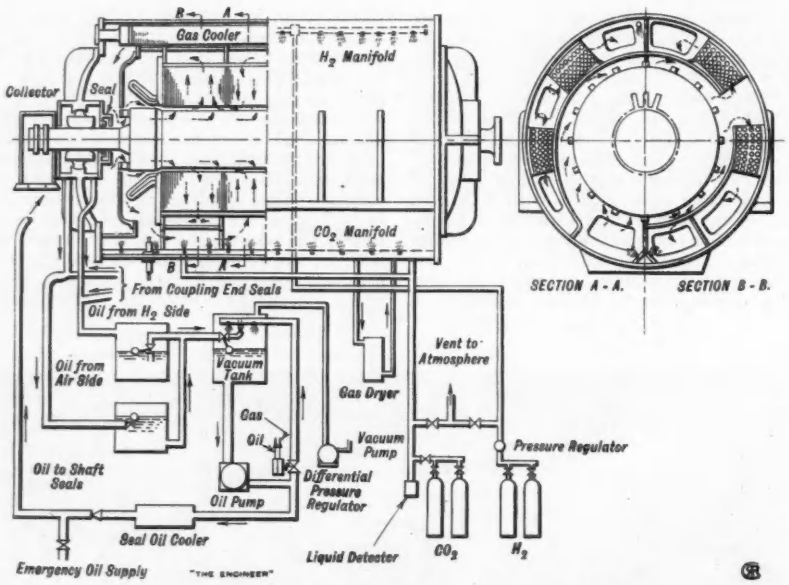


DIAGRAM OF GAS COOLING AND SEALING OIL SYSTEMS

mounted in the stator frame. A typical cooling unit, partly complete, can be seen on the extreme left of our illustration.

Hydrogen Seals

To prevent leakage of gas at points where the rotor shaft passes through the ends of the stator frame, oil-film seals are provided, mounted on the bearing brackets on the generator side of the bearings. Each seal comprises two segmental rings surrounding the shaft and held in position in their housings by garter springs. The clearance between these rings and the shaft is less than the main bearing clearance.

A simplified diagram showing the principle of the gas-cooling and sealing oil systems is given above. For simplicity certain of the components are not shown in the diagram. The oil for the seals is drawn from the main lubricating oil system but is supplied by an independent oil pump to the annular space between the two seal rings and thence flows axially along the shaft in both directions. The oil flowing towards the generator absorbs hydrogen, and the oil flowing towards the bearing absorbs air. Suitable baffles are fitted to prevent oil being drawn into the generator.

The oil supplied to the seals is vacuum treated, so that it will neither release air into the generator nor hydrogen into the bearing oil. After leaving the seals the hydrogen-contaminated oil passes into the seal drain and from there to a hydrogen-detraining tank (not shown in the diagram) and on to the vacuum tank. The air-contaminated oil unites with the bearing oil and returns to the main bearing oil tank. Make-up oil, to replace that returned with the bearing oil, is drawn from the main bearing oil tank (not shown in the diagram) into an air-detraining tank and thence to the vacuum tank. The seal-oil pump thus obtains from the vacuum tank a supply of oil which contains neither air nor hydrogen, and passes this oil through a cooler to the shaft seals.

At the seals the oil is automatically maintained at a pressure above that of the hydrogen in the machine casing by means of a differential pressure regulating valve. The normal operating pressure of the hydrogen is 0·5 lb per square inch above atmosphere and this pressure is automatically maintained by a pressure regulating valve situated between the hydrogen supply bottles and the machine frame. In the actual installation the oil-seal plant, shown herewith, forms a compact assembly in which the seal drain, detraining and vacuum tanks are housed in a single shell, below which are the seal oil pumps and other components.

In the event of a failure of the seal-oil pump or the supply to its motor, an emergency oil supply automatically feeds the seals from the main bearing supply line. A liquid detector with alarm is connected to the bottom of the machine frame to give warning of the presence of water or oil. Some of the hydrogen gas circulating in the machine is continuously by-passed through a silica-gel dryer, and the whole quantity of the gas is passed through the dryer two or three times a day.

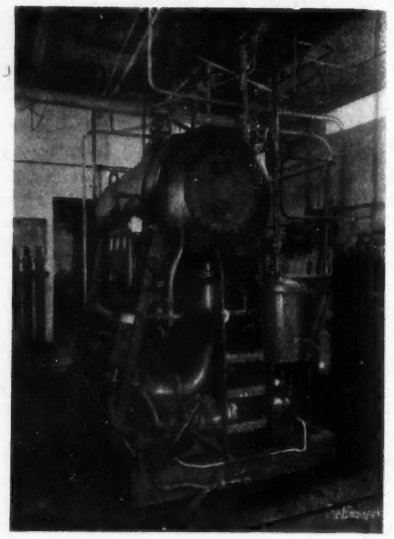
Control Cabinet

Control of the gas system and associated plant is exercised centrally from a control cabinet. The upper four gauge dials on this cabinet give indications of oil-tank vacuum seal, machine gas pressure, and gas temperature. Below these gauges is a hydrogen purity indicator, with a differential fan pressure indicator on the left, and a flow meter for the gas analyser on the right.

Below these gauges is a row of indicator lamps and switches associated with a very comprehensive warning system for any defect in the gas or oil seal equipment. Audible and visible warnings are given for any of the following contingencies:—high machine gas temperature, low hydrogen purity or low gas pressure in the machine, low hydrogen bottle pressure, to indicate when a bottle needs to be replaced. On the sealing-oil side, similar warning is given in the event of low vacuum or incorrect liquid level in the vacuum tank, high and low oil levels in the hydrogen detraining tank, incorrect differential pressure between seal oil and hydrogen, low seal-oil pump pressure, water and oil leakage, high oil level in the seal drain.

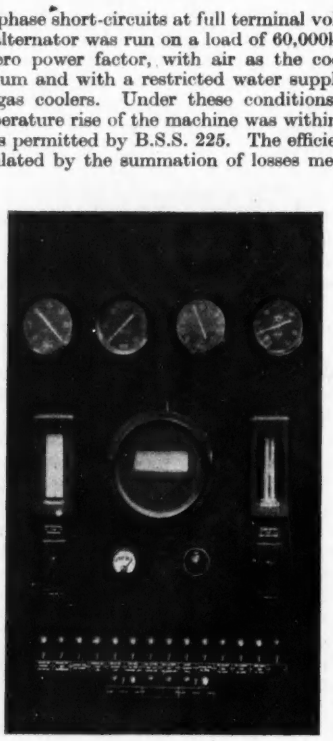
Tests

In preliminary tests the alternator was first run as an air-cooled machine; open and short-circuit saturation curves and losses were determined, the machine being driven through gearing by a 2500 h.p. calibrated d.c. motor. After undergoing a number of three-phase and



PLANT FOR SUPPLY AND TREATMENT OF SEALING OIL

two-phase short-circuits at full terminal voltage the alternator was run on a load of 60,000kVA, at zero power factor, with air as the cooling medium and with a restricted water supply to the gas coolers. Under these conditions the temperature rise of the machine was within the limits permitted by B.S.S. 225. The efficiency, calculated by the summation of losses method



CONTROL CABINET

specified in B.S.S. 269, was 97·7 per cent for a load of 60,000kW, 0·8 power factor as an air-cooled machine.

For operation as a hydrogen-cooled alternator, air was then removed by admitting CO_2. After obtaining a concentration of 70 per cent CO_2 this gas was displaced by hydrogen until the pressure in the casing was 0·5 lb per square inch above atmosphere and the purity reached a value of 97 per cent. Again the machine was driven by the calibrated d.c. driving motor and the open-circuit, short-circuit, windage and friction losses were mea-

sured. The efficiency as a hydrogen-cooled machine, again calculated by the summation of losses method, was 98·5 per cent for a load of 60,000kW and 0·8 power factor. The efficiency gain of 0·8 per cent attributable to hydrogen cooling represents a useful gain of about 480kW at the rated output of 60,000kW.

Commencing on Saturday, May 29, 1948, the generator was subjected to a series of temperature tests at loads of 60,000kVA and 75,000kVA at zero power factor by loading it on to two large reactors of 44,000kVA combined capacity, a number of motor generator sets and a 20,000 kVA synchronous condenser. To save conversion losses during these temperature tests, the generator was synchronised with the B.E.A. system and run as a synchronous motor. Temperature tests were made with hydrogen pressure of 0·5 lb per square inch and 15 lb per square inch in the machine casing.

On a load of 60,000kVA the temperature rise of the stator windings measured by thermocouple between coils was approximately 45 per cent lower when operating in hydrogen at 0·5 lb per square inch, and 60 per cent lower when operating in hydrogen at 15 lb per square inch, than when operating at the same load in air at atmospheric pressure. The stator winding temperature rise was 20 per cent lower on a load of 75,000kVA with the hydrogen at a pressure of 0·5 lb per square inch than on a load of 60,000kVA with air as the cooling medium.

These tests were carried out in a test pit 30ft long, 14ft 6in wide and 16ft 6in deep, specially constructed to accommodate large machines. The gas service equipment and oil supply and testing plant referred to in this article were housed in the pit below the alternator.

Before the demonstration run on June 3rd, the party of visiting engineers was given the opportunity of making a brief inspection of the alternator and associated cooling equipment. The alternator was run up to speed for loading during the factory lunch hour, when the power demand could reasonably be accommodated. After synchronising with the B.E.A. supply, the machine was run for a short time, at zero power factor, on a load of 75,000kVA. This load was applied in stages, the various components being the 44,000kVA reactors, a 15,000 kVA synchronous condenser, and two motor-generator sets rated at 10,000kVA and 6000 kVA, respectively.

Although it is difficult to assess noise under test bed conditions, the demonstration gave some indication of the reduced noise associated with hydrogen cooling compared with air-cooling.

Gas Turbines for Public Electricity Supply*

By H. G. BELL, M.I.E.E., and D. M. SMITH, M.I.Mech.E.

Equipments in Service

During the past three years about twenty gas turbine equipments have been ordered for public electricity supply systems in Switzerland, Roumania, Britain, France, and various South American countries. Gas turbines have also been ordered for central stations in oil-fields to supply power under conditions akin to those of public electricity supply systems. The orders have been placed with various Swiss and British manufacturers. The ratings vary from 1650kW to 27,000kW; ratings in the range of 10,000kW to 15,000kW have been common. Most of these gas turbines are for peak load service or for standby service for hydro-electric systems, but a few have been ordered for base load service in countries where oil or gas fuel is cheap.

Some of these turbines have successfully passed bench tests at the maker's works. So far as the writers are aware only one of these recently ordered turbines is yet in operation on site. This is a compound open-cycle turbine of 13,000-kW rating, installed for hydro-electric standby service at Beznau in Switzerland. It was put into operation during the present year.

The only other gas turbine plant which the writers know to be in service in public electricity supply is the Neuchâtel set, a simple, open-cycle plant. It was installed in 1940, but as it is an emergency set the number of running hours has been limited. The set was in operation eleven hours per day for several weeks in 1947, during a hydro-electric shortage, and the operation was entirely satisfactory.

There are several experimental gas turbines installed in manufacturers' own works and supplying electric power. These are giving advance experience in many respects of gas turbines for public supply systems.

There is a great variety of possible gas turbine cycles. A few representative cycles of interest in connection with this application are shown diagrammatically on Fig. 1. The majority of the cycles shown in this diagram are used in gas turbines which have been built or are in manufacture for electricity supply.

[Subsequent sections of the paper dealt with the various cycles, the conditions affecting performance, and typical components.]

Operating Conditions and Problems

This section deals with some operating conditions and actual or potential problems which may arise in the operation of gas turbine plant for public electricity supply. It deals more particularly with open-cycle gas turbines, on which there is more operational experience than on closed-cycle gas turbines, and on which alone the writers have had personal experience.

The operation of starting a gas turbine is comparatively simple and rapid. A 10,000-kW set has been run up to full load from cold in a period of six minutes. More rapid load fluctuations can be imposed on gas turbines than on steam turbines of similar size and rating without risk of unpleasant mechanical consequences.

Atmospheric Fouling.—Experience with gas turbines has shown that in districts with clean atmospheres or in flight there is no deposit on axial flow compressor blading. In districts with dirty atmospheres a deposit of greasy dirt is liable to form on the compressor blading and cause deterioration of performance. Hitherto this problem has arisen mainly in connection with the bench testing of jet propulsion engines. This experience leads to the recommendation that for gas turbines to be installed in industrial districts, provision should be made for cleaning the inlet air. Methods of cleaning which are receiving consideration are filtering, air washing by water spray, and electrostatic precipitation. This provision is unnecessary in clean-air districts.

Power station experience has shown that atmospheric dirt, even in the worst industrial districts, does not deposit in air heaters. The physical reason for this difference in behaviour is not certain, but it may be connected with the low velocity in the air heater passages. It is therefore unlikely that there will be trouble due to atmospheric fouling in the intercooler or on the air side of the heat exchanger in gas turbine plant.

Combustion.—British experience with gas turbines has been mostly with distillate fuels. It has been found that such fuels can be burned with high combustion efficiency (99 per cent or more) and without production of smoke or soot over the full operating range of loads. A combustion chamber developed for fuel of one grade can burn fuels of other grades, including residual grades, but frequently a minor modification to the primary chamber is required to burn another grade of fuel with complete freedom from smoke or soot. It may therefore be necessary to change the primary member of the combustion chamber if a change is made from one grade of fuel to another. Experience with residual fuels in gas turbines is limited to date, but in the light of the gas turbine combustion problems already solved there is a good prospect that a relatively small amount of development work will be sufficient for combustion of Pool fuel oil in land power gas turbines. Considerably more development work will probably be necessary for successful combustion of Pool heavy fuel oil.

Combustion Chamber Maintenance.—Thermal conditions in the primary region of the combustion chamber are such that it is not at present possible to guarantee that the primary member of the combustion chamber will have the same life as the other gas turbine components. This applies whether the member is of all metal or of part refractory construction. Combustion chambers are therefore arranged to be readily accessible for inspection and for renewal of certain internal components. Maintenance problems are likely to be more severe in the reheat chamber than in the main combustion chamber. This occurs because the entering gases are at higher temperature in the reheat chamber and it is therefore more difficult to keep down the temperature of items within the reheat combustion chamber.

Experience alone will show at what intervals inspection and renewal will have to be carried out. In course of time, developments will give improved durability. In this connection it may be remarked that in jet propulsion engines, which have far higher rates of heat release in combustion chambers than will be used in land power plant, combustion chamber primaries of thin sheet metal have been developed to a point where they are comparable in durability with the other high temperature components of the engine.

On closed-cycle plant, air heater maintenance problems should be similar to those of oil-fired boilers with steam walls; they may be aggravated by the fact that the maximum temperature of the air heater tubes is higher than is normally employed in superheaters.

Turbine Maintenance.—Turbine design generally follows steam practice, with due allowance for the higher temperatures. The reliability of turbines, as far as can be foreseen by the designer, should therefore be as great as for steam turbines. The question arises whether there is anything in the unfamiliar operational conditions of gas turbines which may entail trouble in service.

In the high temperature end of the turbine, the temperature and long life present a novel combination. Much higher temperatures with the same materials are already familiar in short life operation; there is a certain amount of material test information for intermediate life; and the temperature-stress-life characteristics are well known for materials already familiar in steam turbine construction. Designers therefore have a reasonable basis for their calculations. The most highly stressed parts in turbines are usually in materials and at temperatures with which long life experience has already been obtained in steam turbines.

The austenitic steels and the Nimonic materials used for high temperature turbine blading are highly resistant to corrosion, and no trouble with corrosion or corrosion fatigue has been met with in jet propulsion engines. Experience alone will show whether turbine operation for long periods at lower temperatures is accompanied by equal immunity.

The possibility of turbine deterioration due to deposit of ash or soot on the blading has to be considered. Experience with distillate fuels indicates that most fuels give no ash deposit, but some give a thin coating of fine, soft ash. Heavy fuels are likely to have higher ash content of different composition, and some batches of heavy fuel may present ash deposit problems. Soot does not deposit on surfaces above 350 deg. Cent., so that soot deposit will never take place on turbine blading.

Heat Exchanger Fouling.—As already mentioned, fouling on the air side of the heat exchanger is unlikely to present a problem. On the gas side, however, deposit of ash from the products of combustion may occur in any part of the gas side, and deposit of soot may occur in the cooler parts. The possibility of soot deposit is bound up with the combustion problem; good combustion will give no soot deposit.

It is not yet known whether ash deposit will be at all rapid nor what form the ash deposit may take (e.g., hard, soft or sticky). Different batches of fuel have different ash contents and the character of the deposit will also vary with temperature of the surface where deposit takes place. Pending more experience in service,

* Incorporated Municipal Electrical Association Convention, Eastbourne, June 8, 1948. Abstract.

provision seems desirable for ready inspection and for easy cleaning of elements if required.

Comparison with Steam Practice

In the notes which follow on comparison with steam practice, the gas turbine primarily in mind is an open-cycle compound set of 15,000kW rating, operating on cycle (f) of Fig. 1. A lay-out of an engine-room containing two such sets is shown in Figs. 2 and 3.

Buildings.—The cost of civil works associated with generating plant is always a considerable item and may amount to over 30 per cent of the whole cost of a new station. The costs of civil works have increased and are increasing more quickly than the cost of plant, so that economy in buildings is of first importance.

Figures for the volumes of conventional boiler houses and engine-rooms to accommodate steam generating plant are as follows :—

	Target	Average
	Cubic feet per kW	Cubic feet per kW
Turbine house, including pump and auxiliary switchgear ...	15	16
Boiler house ...	25	29
Offices	5	5
Total	45	50

In the case of gas turbines there is no necessity for a separate boiler house, as the whole of the plant may be accommodated in a single building of engine-room construction. A lay-out as indicated in Fig. 2 to accommodate two 15MW equipments, requires approximately 20 cubic feet per kW, and a lay-out for two 15MW and one 30MW requires 18 cubic feet per kW. There will be some slight saving in basement height due to the absence of steam condensers, but the ducting associated with a gas turbine which is of substantial dimensions will usually require a basement not very much smaller than is required by a steam condenser.

In addition to the financial advantages of reduced first cost of buildings, the smaller space requirements will frequently permit the installation of plant at important load centres where the installation of further steam plant is not possible.

Material.—The total weight of material in a gas turbine and its associated equipment is estimated to be only one-third of the weight of material required for the equivalent steam plant. The heaviest indivisible item in the engine-room will be the generator stator, but this is not generally handled by the crane. The heaviest crane lift in normal maintenance work of a 15,000-kW set will not exceed 12 tons, and of a 30,000-kW set 22 tons.

The heaviest component is liable to be the heat exchanger; but this will not be handled as a whole, and in the station shown is not under the engine-room crane.

Cooling Water.—Condensing water as such is not required for a gas turbine, but it is generally desirable to cool the air after the first stage of compression to restrict the work done in the second stage of compression. Some cycles use multi-stage intercooling. The cooling is done in an intercooler, and as the heat to be dissipated is sensible heat only, the question of latent heat does not arise; the intercooler is much smaller in dimensions than the conventional condenser and the amount of heat to be disposed of is less than in a steam condenser. Actually the heat rejected at this stage is of the order of one-third of that rejected in the condenser of a steam turbine of equal rating. The intercooler has other advantages as compared with the condenser; as it is connected to pipework rather than to a turbine casing, expansions are more easily catered for, and accommodation on restricted sites is made simpler due to the greater freedom in locating the cooler.

As the air in the cooler may be required to be cooled from a temperature of say 300 deg. Fah. to 80 deg. Fah., much larger temperature gradients will exist than in a steam condenser, where the entering steam has a temperature of 90 deg. Fah. only. It is practicable, therefore, to utilise a greater temperature rise in the cooling water than would be permissible for a steam turbine. Low inlet temperature of the cooling water is, however, necessary, and a fall in inlet water temperature is usually more beneficial than with a steam turbine.

With closed-cycle plant the heat to be removed by the cooling water is much greater than with open-cycle plant, and is of the same order as that to be removed from a steam condenser.

Make-up Water.—No make-up water is required for a gas turbine, and as make-up is usually obtained from town's mains, and may require to be softened or passed through an evaporator, this is a material simplification. The necessity for chemical supervision of the boiler water is also avoided.

Chimney Discharge.—The gases discharged from the chimney will be similar in composition to those used in oil-fired boilers, but under present design conditions will have a higher temperature. The volume to be dealt with will be over five times the volume of gases from equivalent boiler plant. There will be no solid grit, but sulphur compounds will be present in some degree. In view of this it will probably be desirable to construct chimneys comparable in height to those required for steam stations, but with larger cross-sections. The higher temperature of the gases will enhance the chimney effect, and there will, of course, be no necessity for induced or forced draught fans or for dust or grit arresters. In many cases steel stacks will be satisfactory.

Fuel Storage.—The storage of fuel for an oil burning gas turbine is comparable with oil storage for boiler firing, which is, of course, much more economical in space than the storage of solid fuel. As a comparison, sufficient oil fuel for a gas turbine for 400 hours' running on full load at 15MW (2·4 weeks) can be stored in a tank with a diameter of 53ft and a height of 35ft. The equivalent storage of coal would require a site

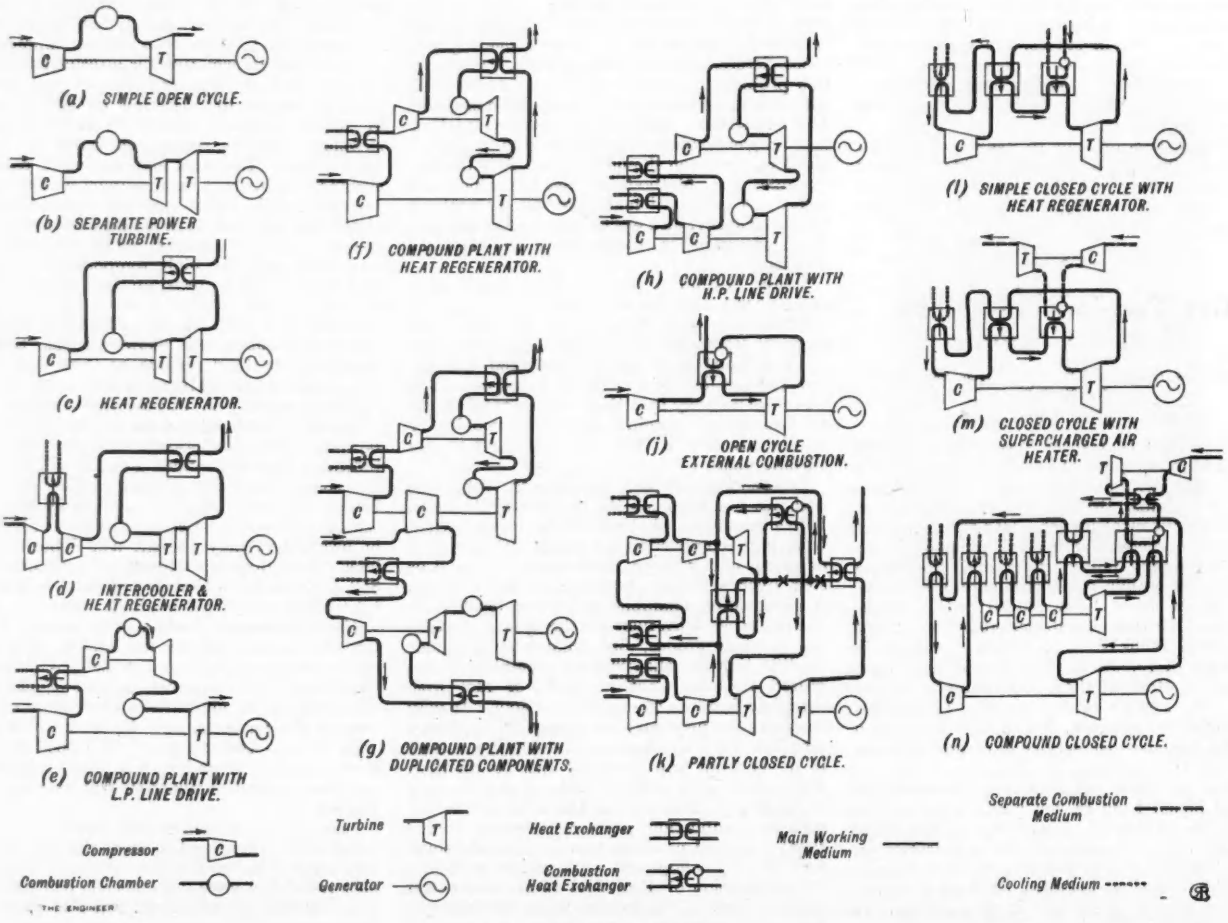


FIG. 1—*Gas Turbine Cycle Diagrams*

approximately five times as great. The handling of oil fuel is much simpler than that of solid fuel. As a normal drag scraper, conveyors, &c., with their heavy maintenance, are replaced by pumps and pipework the maintenance costs and operating costs will be materially reduced. The energy used in the elevating of the fuel to lofty bunkers will also be saved.

Auxiliary Plant.—The gas turbine requires much less auxiliary plant than a conventional steam station and the amount of switchgear is correspondingly reduced. The power absorbed by auxiliaries is also far less. The gas turbine requires no boiler feed pump, extraction pump, induced draught fan, forced draught fan or secondary air fan. The circulating water pumps are greatly reduced in size. The fuel handling pumps for oil are simpler than the conveyors, drag scrapers, grabs, and other coal-handling plant. Barring motors and a starting motor are required for gas turbine plant, but take little of the units generated.

At full load, a 15,000-kW gas turbine plant will absorb 1 per cent of the output in power to auxiliaries and station services. A steam turbine plant of similar rating with steam conditions 400 lb per square inch gauge, 850 deg. Fah., would require at full load 5 per cent of the output for auxiliaries. The difference of 4 per cent of the output in favour of gas turbine plant is increased at partial loads.

Conditions Favourable to Gas Turbine Installation

The following considerations influence the present choice as between gas turbines and steam turbines for extensions to generating plant for public electricity supply:—

(1) A gas turbine station is lower in capital cost than a steam station.

(2) A gas turbine station offers a thermal efficiency of the same order as a new steam station of similar rating, but can burn only oil or gas. A steam station can burn coal, which in this country is cheaper per heat unit than oil or gas.

(3) A gas turbine station has no standby losses, and sets can be started and put on load more rapidly than steam sets.

(4) The normal operating staff of a gas turbine station is less than for a steam station.

(5) There is not yet sufficient experience with gas turbines for land power plant to enable actual maintenance costs to be quoted, but there is reason to expect that the maintenance charges for open-cycle gas turbine plant will be lower than for steam plant.

(6) Gas turbine plant can be installed on a smaller site than steam plant.

For base load stations in this country, the paramount consideration is the fuel cost: a gas turbine base load station is uneconomic in comparison with a coal-fired steam station. Base load gas turbines become economic in certain overseas countries where oil or natural gas is cheap.

For operating conditions below a certain load factor, the gas turbine becomes economic as the saving on capital charges outweighs the additional cost of the fuel. A full examination of economic conditions can only be made for specific cases where sufficient is known or assumed as to operating conditions. The comparison is influenced by many variables, including the rate of capital charges, the period of amortisation, the nature of the load (e.g., frequency of starting and stopping and to what extent partial load running is required), and the costs of the respective fuels. Broadly, however, the load factor below which gas turbine plant becomes economic in this country as compared with coal burning steam plant appears to be about 16 per cent to 18 per cent.

The application of gas turbines for electricity supply should receive special consideration in the following cases:—

(1) For peak load sets, especially for existing station sites in towns close to areas of heavy demand.

(2) For standby sets, as in conjunction with hydro-electric systems.

(3) For stations supplying high maximum loads of very low load factor, as for instance, for supplying power to aeronautical research establishments operating large wind tunnels.

(4) For stations which, in the absence of gas turbine plant, would have been equipped with oil or gas-burning steam plant.

Future Development Possibilities

The field of application for gas turbines in this country is at present more restricted than that for steam turbine plant. The field of application would be greatly widened by developments giving the following results:—

(1) Increase in thermal efficiency without increase in capital cost per kW.

(2) Possibility of burning coal without much increase in capital cost per kW.

Various possible developments may contribute to attainment of the first objective. Advance may come through the use of higher maximum cycle temperatures, in consequence either of novel designs or of metallurgical development. Any increase obtained in the efficiency of individual components of the gas turbine will be beneficial. Progress in heat exchanger design may lead to a new type of heat exchanger which will give higher thermal ratio with no higher capital cost than at present. It is known that more elaborate cycles than are now commonly used are capable of giving higher thermal efficiencies, but the overall economic value of these more elaborate cycles is not yet clear. Running experience with the compound plants now being built will indicate the most profitable direction of cycle development.

Thermal benefit would be obtained by making use of the waste heat from the gas turbine cycle, as is sometimes done for the steam cycle. The gas turbine has potentialities in this respect for certain industrial applications.

The cooling water from the intercooler is at too low a temperature to be of much use. The exhaust gas from open-cycle plant is at a higher temperature, but to make use of this heat involves providing an additional heat exchanger, which increases capital cost and entails a pressure drop which adversely affects performance.

The steam turbine is usually better adapted to district heating than is the gas turbine, and the use of peak load plant for district heating is less economic than the use of base load plant. There appears to be little scope for the use of waste heat from gas turbines in public electricity supply so long as gas turbines are installed for peak load and standby purposes.

A number of methods of burning coal in gas turbines can be envisaged. It may be possible to burn coal internally in the cycle, either pulverised or in some special type of furnace; or to gasify the coal by any one of various methods and burn the gas internally or to use external combustion, either with open-cycle or with closed-cycle plant. The gasification process may yield by-products of value. Development work is already in progress on some of these coal-burning methods, but a good deal more work will probably have to be done before any one is a commercial success. For all methods the capital cost per kW will be higher than for oil-burning gas turbine plant; in consequence, the oil-burning gas turbine will remain economic for certain conditions of application even after coal-burning gas turbines are developed.

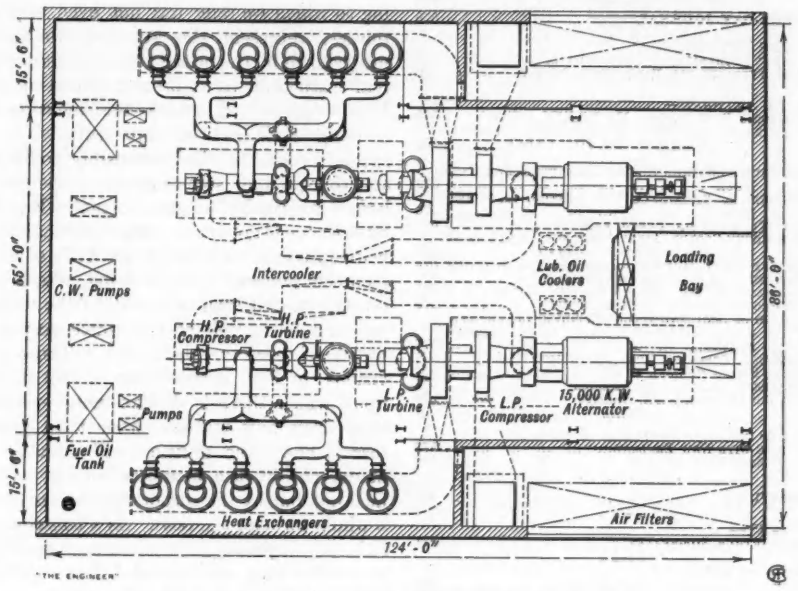


FIG. 2—*Plan Arrangement of Two Gas Turbo-Alternators in Station*

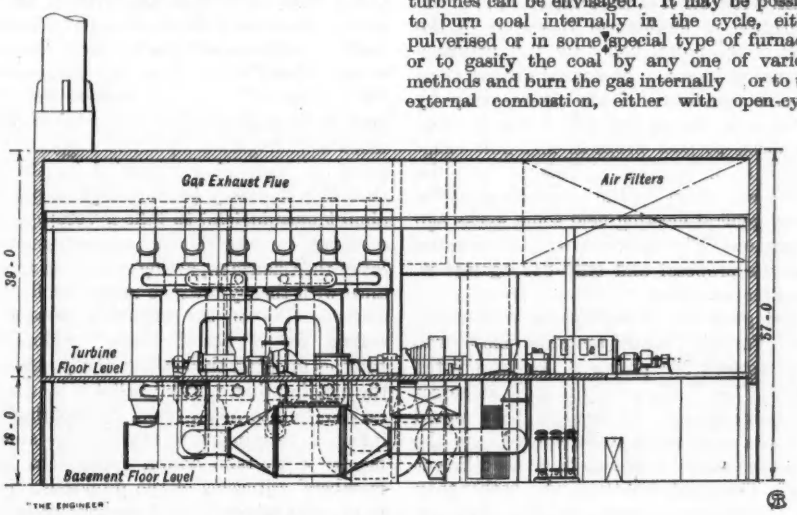


FIG. 3—*Elevation of Gas Turbo-Alternators in Station*

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THE "MECHANICALS" POSTAL BALLOT

THE publication in the June *Journal* of the Institution of Mechanical Engineers of the result of the postal ballot for and against a proposal to increase the annual subscriptions of some two-thirds of the membership by 25 per cent reveals how slight was the real opposition to that proposal and how exaggerated an impression of division upon the matter was given by the proceedings of the special general meeting held some weeks ago in London. The figures were 5179 for the Council's proposal and only 849 against it. Moreover, even those figures, it seems to us, suggest greater opposition than there really was. For how many amongst those who voted against the proposed increases voted that way not because they thought increases were unnecessary, but because they would have preferred them to be spread over the various classes of members in some different way? The number of those who, rather than contribute more as members, desired to see the Institution contracting its activities or living upon accumulated savings or who believed that the Council was not sufficiently active in ensuring that the Institution was efficiently run, must have been very small indeed.

But the fact that the result of the postal ballot is so very much in conflict with the impression that the prior special general meeting gave of some considerable opposition to the Council's proposal, necessarily invites the question whether that meeting served any useful purpose. Obviously it did not at all satisfactorily represent the feelings of members as a whole. No meeting of at most a few hundreds—there were, in fact, far fewer present—can, we suppose, be expected adequately to represent all of the many thousands of members of the Institution. Yet the meeting to which we refer did not even approximately represent the approach to unanimity shown by the postal ballot. Is it not the real truth that, as at present drawn up, the by-laws do, indeed, ensure that such a special meeting shall *not* be representative? A special meeting is called, ostensibly, to discuss and to vote upon some measure to be placed before it, usually by the Council. But the by-laws lay it down that either the Chairman, who represents the Council, or a body of seven members present at the meeting, whether or not dissatisfied with the result of the voting, can call for a poll of the whole corporate membership of the Institution. Those provisions, in fact, ensure that in any matter upon which there is disagreement—practically, upon any matters other than purely formal ones—the decision will actually be made, not by the members present at the meeting, but by the corporate membership as a whole through the post. As a consequence it is not surprising that when such meetings are called they are attended more particularly by those who come to criticise or to attempt to amend. What reason is there for those who are agreeable to the proposition and sure that a decision will be put to a postal vote to be there? Inevitably, therefore, there will be a predominance of critical speeches. That fact alone would make the task of the Chairman unenviable. In practice, however, he labours under further disadvantages. Under the more practical rules of the "Civils" and "Electricals" the proposal to be considered by a special general meeting has already been decided by a postal ballot or through the device of proxies before the meeting opens. How powerless and ineffective the meeting is to affect the issue is thus openly revealed to all. But about a "Mechanicals'" special general meeting, held, as it is, before the ballot takes place, there still lingers a spurious suggestion of power—a suggestion supported by the fact that it is necessary (even though in practice almost meaningless) to take a vote by show of hands. It may thus fall to the unenviable lot of the Chairman, acting strictly in accordance with the by-laws, to appear to flout an adverse vote of the members present by calling for a postal ballot. Moreover, bearing in mind throughout the progress of the meeting that a postal ballot is inevitable, he has, too, to seem, often, overbearing and inflexible in refusing to countenance amendments or to take action consequent upon members' criticisms of the proposals. It is, to our way of thinking, a remarkable tribute to the restraint of chairmen and members alike that meetings held under such by-laws have not been more stormy than in fact they have. For all the influences are present most likely to exacerbate irritated tempers. But such restraint should surely not fairly be asked either of the Chairman or of members. We are therefore driven to ask again, as we asked in these columns some weeks ago, whether it would not be desirable to abolish meetings of such a character? For meetings at which the Council is made to seem repeatedly at odds with the members can do nothing but harm to the good name of the Institution. Is there, in fact, any good reason why the Council should not have the power, if it so desires, to put any proposal directly to a postal ballot without first calling a special general meeting to consider it?

Sooner or later, we believe, those questions will need discussion. But for the moment no shadow of a special general meeting seems to lie across the immediate future, except for annual general meetings, which no one has any desire to abolish. It remains for us, now, to congratulate the members of the Institution upon the wise decision they have made. It may be—it has often been suggested—that some of those who join the Institution do so merely for the benefit they expect to receive from placing certain letters after their names. Perhaps it is true of a small proportion of the members that they think more of what they can get out of the Institution than of what they can put into it. But clearly the greater number think more deeply. As the heavy voting in this postal ballot shows, they take a high pride in the achievements of the Institution and wish it to continue to play in the future the great part it has already played in the past in fostering technical, educational and other developments in the engineering industry and upholding in the face of the world the prestige of British mechanical engineering. We are made happy to see that upon such a matter, despite the different impression created by the London special general meeting, virtual uanimity reigns amongst the members of the Institution.

GAS TURBINES FOR ELECTRICITY SUPPLY

So far, although there are many plants of a different character, there are only two gas turbine installations for public electricity supply operating in the world to-day. Both are in Switzerland. One is a 4000-kW set at Neuchatel, installed as long ago as 1940; the other, the 13,000-kW Beznau set, which started operation in the present year. Significantly, both are, in effect, stand-by sets, the first having been installed in a bomb-proof underground station for use under emergency conditions, and the other only coming into operation when hydro-electric power runs short. A number of other sets are on order and under manufacture here and in Switzerland, and several manufacturers, here, in Switzerland, and in America, have experimental plants in operation. There is no doubt that in a short while a number of gas turbines will go into service for public electricity supply or for purposes closely akin to that kind of supply. The moment was therefore timely for the reading of such a paper as that presented by Mr. Ball and Dr. Smith at the I.M.E.A. convention, held at Eastbourne during this week.

If the logic of that paper may somewhat dash the rosier hopes of those concerned with the development of gas turbines, it is, as will be seen from the abstract we print upon another page, a sober, rational document. The new prime mover will undoubtedly sweep the board for the propulsion of high-speed aircraft. Its high thermal efficiency relative to that of the steam locomotive

may allow it to compete successfully upon the railways. The small space in which much power can be packed may allow it to be competitive on shipboard with the oil engine, despite its higher fuel consumption. It clearly has applications industrially as in a steelworks, where cheap gas may be available as fuel; and it has advantageous qualities for use in research and similar establishments, where high power outputs may be required for relatively short periods. But for electricity supply it has to compete directly with the steam turbine under conditions which allow that latter unit to develop its economy to the full. For that service as Mr. Field emphasised in the discussion, "the factor of thermal efficiency divided by the cost of fuel per B.Th.U. is bound to be decisive for medium and high load factors." The steam turbine has, it is true, a higher thermal efficiency, little if any higher than a gas turbine of similar power. But it is able to use a fuel, coal, that is less costly per B.Th.U. than the oil used by the latter prime mover. It is also true that the capital cost of a gas turbine can be substantially smaller than that of a steam plant, particularly if open cycle machines are used. Moreover, according to the paper, a steam station needs a building providing some 45 to 50 cubic feet per kW, whereas the gas plant needs only 18 to 20 cubic feet, providing a further economy in capital cost. But, to quote Mr. Field, "a case for an open-cycle gas turbine can only be made for land power purposes here in Britain by taking the savings in capital cost as compared with steam plant and using these savings as long as they will last to subsidise the more expensive fuel." Only when, through intermittent usage, the fuel cost becomes relatively low in relation to the capital cost over the life of the plant does the gas turbine for electricity supply become an economic proposition. Hence, at present, a gas turbine unit is suitable only as a stand-by or peak load plant and even then only where the load factor is very low indeed. "The load factor below which gas turbine plant becomes economic in this country as compared with coal-burning steam plant appears to be about 16 to 18 per cent," say the authors of the paper. Coal could no doubt be used as the fuel if the gas turbine plant used the closed cycle. But that type of plant needs in addition to all the other equipment it has in common with an open plant a heat exchanger equivalent to a boiler plant and it is dubious whether its capital cost would then be less than that of a steam plant.

Yet the protagonists of gas turbines may take courage. The gas turbine as a practical power-producing machine is young, so young in fact that it can safely be said that much written into the paper about maintenance and certain other factors is uncertain and still remains to be proved. Moreover, development has still much further to go. Research is already taking place into the possibilities of burning coal as the fuel for gas turbines; it seems possible that higher thermal efficiencies may be attainable without appreciable increases in capital cost; and the overall economic value of certain cycles more elaborate, but known also to promise higher thermal efficiencies, remains to be tested. It is worth recalling, perhaps, that as steam turbines developed it was found economically worth while to use more complicated cycles than those at first employed. Before the war the Swiss were well ahead of any other nation in the design and construction of gas turbine machinery. As far as land plant is concerned they still remain so, as is evidenced by the existence in that country of the only two operating gas turbine power stations for public supply. But during and since the war British engineers have had the advantage of leading the world in developing the jet propulsion aircraft gas turbine. Very different though the two devices are, many lessons learnt from aircraft plant can be applied in designing and building stationary units. Thus, though some of the land turbines under construction in this country are being built under licence to Swiss firms, we are glad to learn that at least one firm in this country is setting out to make its own designs. For though in this well-watered, coal-bearing country the gas turbine cannot now compete with steam plants for base-load duties and seems indeed not very likely ever to do so, there are many lands across the sea whose economic and climatic conditions are different and there are many applications for the gas turbine other than for electricity generation for public supply. Given a continuance of that energy which is being shown in this country in the development of this new power unit the supply of gas turbine plant may in the not distant future provide a substantial contribution towards the expansion of our exports and to raising the prestige of British engineering abroad.

Obituary

SIR ARTHUR SIDGREAVES

SIR ARTHUR SIDGREAVES, of "Farside," Manor Road, Penn, Buckinghamshire, whose sudden death occurred at Green Park Station, London, W, on Monday, June 7th, was an outstanding figure in the British motor-car and aircraft engine industries. For seventeen years, from 1929 to 1946, he was the managing director of Rolls-Royce, Ltd. Arthur Frederick Sidgreaves was born in 1882, and he received his education at Downside College. In 1902 he joined the pioneer firm of motor car designers and builders, S. F. Edge, Ltd., and from the beginning took a keen interest in the application of the internal combustion engine to road transport. For some years the firm of S. F. Edge was the sole concessionnaires for the sale of Napier cars, which brought young Sidgreaves into close touch with the Napier firm. He spent some time with the firm of D. Napier and Sons, Ltd., but went back to S. F. Edge, Ltd., with which he remained until the outbreak of war in 1914. He then joined the Royal Naval Volunteer Service, and was drafted to the Royal Naval Air Service. When the Royal Flying Corps and the Royal Naval Air Service were joined, to form the Royal Air Force, Mr. Sidgreaves was gazetted major, and was drafted for service with the Air Ministry in the aircraft engine section. He was given charge of the production department which, at that time, had been specially established for increasing the production of the Rolls-Royce aero-engine. Early in 1919 he returned to D. Napier and Son, Ltd. In 1920, however, he joined the staff of Rolls-Royce, Ltd., as export sales manager, and was promoted to general sales manager in 1926. In 1929 he became managing director of the firm, a position he continued to hold with distinction until 1940, when, at his own request, he retired from active business. He was made an O.B.E. in 1918 and was knighted in 1945.

It was under Sir Arthur's direction that Rolls-Royce developed the liquid-cooled, in-line "Merlin" aircraft engine, with which most of the British fighting aircraft were powered during the recent war; but he also took a leading part in developing the jet engine, which in the "Derwent V" won the air speed record in 1945 and the year following.

Sir Arthur was also responsible for the decision which resulted in Rolls-Royce co-operating with Vickers-Armstrongs in the production of special aircraft for the 1931 Schneider Trophy contest, the winning of which did much on the engine side to further the design and construction of high-power aircraft engines. When in the years before the war, the Government decided to establish a "shadow factory" scheme, Sir Arthur Sidgreaves, on behalf of his firm, undertook to build an entirely new factory at Derby for the increased production of "Merlin" engines, which, due to his foresight, were then being used for Royal Air Force machines in increasing numbers. Later on new Rolls-Royce factories were built and staffed at Crewe, and at Hillington, near Glasgow, and production was commenced after construction in a very short time. Arrangements were also made to manufacture the engine in America. It is true to say that Sir Arthur Sidgreaves did perhaps more than any other man in the task of designing, making and delivering to the Royal Air Force the tools with which it won the Battle of Britain, and co-operated so successfully with the other Allied air forces in the later stages of the war.

Sir Arthur had gifts which from the beginning of his career marked him out for high administrative positions. He had a wonderful memory which aided him in his great work. While he was quiet and reserved in character, he made many friends who will mourn his tragic death at a comparatively early age.

Literature

The Railways of Britain, Past and Present. By O. S. NOCK. London, 1948: B. T. Batsford, Ltd. Price 15s.

IN this delightful volume an author well known to readers of THE ENGINEER discourses about the railways of Britain, not only as one who knows them well, but loves them, too. Sometimes he quotes authorities, sometimes draws upon his own rich experience; but always, whether he is firing a salvo of statistics or adroitly summarising official reports, or recording his personal impressions of a misty morning from a Highland footplate he maintains the "entertainment value" of his pages. For this is not a technical work; it is a book for the ordinary reader. For the man who has loved trains and railways since he was a boy, and for the man, and woman, who have never known or have lamentably lost the romance of the railways of Britain and are more prone to criticise than sympathise with that splendid heritage.

It is a moot point whether we enjoy more the contemplation of the remote past or of that past which lies on the doorstep of our own times. Whether in the present case we are more attracted by the transport systems of Elizabethan or even Georgian days than by the growth of the railways amongst whose leaders and captains were many men known

to ourselves and whose notable works and productions are within our own living memories. There are men living at this day, and "not so very old either," who can recall the sensation of the Tay bridge disaster, and plenty more who remember the drowsy oil lamps in the Holyhead boat train and the hinged covers that their fathers drew over their dimness at "bedtime." The memory of such things, often unpleasant in themselves, is pleasant now. But they are on the threshold. A little further back belongs to the unreal world, the world of history, and it takes a skilful author to make it live for us as Mr. Nock makes it live.

He divides his work into three main parts: first, the story of how British railways, and that means the railways of the world, came into existence; then he takes us to their working and equipment, often contrasting the near past with the actual present; and finally he passes in review the progress of Britain's railways in a hundred years. To end it all he devotes a longish chapter to "A Miscellany of Oddities, Anecdotes and Fiction." Here he ranges over such subjects as ghost trains, Dickens' knowledge of railways as revealed in "Edwin Drood" and Sherlock Holmes in "The Adventures of the Bruce Partington Plans," through the passing of railways, like the Lynton and Barnstaple, dear in memory to many of us; strange accidents like the disappearance of a locomotive on Lindal Moor, and dreadful accidents like that at Quintinshill in 1915, or like that near Headcorn in 1865, in which Charles Dickens was involved; or the names of signalboxes, famous railway "races" and the "timing" of trains by passengers.

It would be vain to endeavour to follow Mr. Nock through all his pages, amongst which we have not found one that was dull. It would be equally vain to regret omissions, for the limits prescribed by the publishers for the admirable series to which this volume belongs would have been far exceeded. The charm of the work is the "personal touch," which shines through it and which disarms all but praise. Mr. Nock draws freely upon his own experiences on footplates and shows, as Mr. Edward Livesey has so often shown in our columns, that railway scenery and railway "effects" are felt more from that situation than from the comforts of a Pullman.

The volume is very copiously and very well illustrated. Indeed, in some cases the illustrations are the only "text," for little or no letterpress illuminates them. That leaves us, at times, wishing, as, for instance, the striking pictures contrasting the semaphore signal gantry near Darlington in 1939 with its dozen or more posts and the same gantry bare save for colour light signal in its centre. One feels that the general reader would like to know how this marvel has been attained. But why complain? There is enough and to spare in what Mr. Nock has given us; enough to make the dullest reader feel some of the romance of railways and the grumpiest feel some pride in an achievement that Great Britain gave to the world.

Works Organisation and Management. By E. J. Larkin. London: Sir Isaac Pitman and Sons, Ltd. 1947. 515 pages. Price 40s. net.

In days when increased production is being preached in season and out of season, an authoritative work on the organisation of an engineering factory is very *apropos*, and in rewriting this book, which first appeared in 1940, the author has evidently had this thought before him. He has endeavoured in the compass of one volume to cover the whole field of works organisation, and has succeeded so well that a complete picture is presented, comprehensive enough for the seasoned engineer to obtain valuable suggestions, and yet sufficiently condensed for the student to be able readily to appreciate the general structure. This work is admirably suited to those who propose to take the paper on Industrial Administration in the Institution of Mechanical Engineers' Associate Membership Examination.

It is not possible even to mention all the different branches that are discussed in the thirty chapters that are compassed in this book, beginning with a general survey of the management function, proceeding to the selection of the best site for a factory, laying out and equipping it, and then showing how the various functions and activities are co-ordinated. Stress has rightly been placed on the importance of due consideration to the personnel of the establishment, and we are glad to notice that Mr. Larkin has adopted our suggestion of giving the cost accountant a place, for his services are invaluable, and this department might well have been considered in detail, and some indication given as to the means the author would adopt for interlocking the cost account with the general account. We should like him to have placed cost accounting and estimating under the same chief. It is suggested that the inspection staff should not be under the control of the works manager, who is himself responsible for producing the work that has to be inspected. The necessity for the elimination of waste in every shape or form is so important that a whole chapter is devoted to it, and we notice that one of the sources of waste instanced is that of holding unduly large stores. It was for this reason that we recommended that in addition to determining a maximum and minimum stock to be held, an ordering level should also be stated. Without this the storekeeper is prone to keep as near as possible to the maximum to ensure never falling to the minimum. In a large factory this would represent a substantial sum in idle capital: we are sorry Mr. Larkin has not appreciated this.

There are many other points on which we should like to offer friendly criticism, realising the truth of the quotation from C. B. Cochran at the end of the chapter on Personnel: "Only age can bring experience, and only experience can give criticism any value"—but we must resist the temptation, concluding by congratulating the author on the able manner in which he has handled a complex subject.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

TRADE WITH NEW ZEALAND

Sir,—During the past ten years New Zealanders have become well used to restrictions of imports as a matter of our government's general policy. When import difficulties were complicated by restrictions on trading with hard currency countries, it was at least hoped that there would be an opportunity of expanding business with the Mother Country.

As all New Zealanders have a feeling of deep affection for the old country, and want to do anything in their power to help her regain her former status in world markets, it is a matter for extreme regret that this hoped-for expansion has not been possible.

To the contrary, the 1948 import licensing schedule contained severe cuts in allocations for United Kingdom goods.

The writer has the privilege of being Regional Manager for New Zealand for Oral (Great Britain), Ltd., and therefore has the interests of a large number of British manufacturers very much at heart. May I be accorded a few lines in your paper to assure manufacturers throughout Britain that importers in New Zealand are bringing all possible pressure to bear on the authorities with a view to increasing trade with the Old Country.

We are earnestly striving for a more generous allocation of licences in the future and sincerely trust that 1949 will see trade with England more in line with the general desire of all true New Zealanders.

Roger C. Aickin

Auckland, C.I., New Zealand, May 24, 1948.

THE ENGINEERS GUILD

Sir,—There is now an Engineers Guild, formed to protect the interests of professional engineers, Civil, Mechanical and Electrical, by, one feels, frustrated engineers. It is claimed that the Guild is not a trade union; it does not have to be called one to behave like one, and the memorandum it has recently sent out to professional engineers shows evidence of the trade union mentality. Must we have another such organisation, a defensive organisation, another "vested interest"?

Since professional standards are protected by the three great engineering Institutions, this new association can only "protect" commercial interests. But this is not the right way.

It is stated in the memorandum:—

"Immediate attention will be given to the following points:—

"(1) Representation of the engineering profession at the highest levels of planning, control and direction.

"(2) Acceptance of engineers as eligible candidates for the most responsible administrative posts.

"(3) Protection of the public from unqualified practitioners, and reservation of work for those qualified to do it.

"(4) Recognition and adequate remuneration of the services of engineers at all levels."

Surely the only way for engineers to attain these objectives is to qualify for and earn them. To obtain representation at the highest levels, to be eligible candidates for responsible posts (management as well as administrative), to obtain adequate remuneration, engineers must qualify by enterprise, and free competition, not by forming a closed shop or a protective body.

The reason in general why engineers do not obtain the recognition which they feel is their due is because they too narrowly specialise; they become expert technicians but neglect the study of man and management. Management and administration, which are usually remunerated higher than technical work because of the scarcity value, in the modern complicated industrial world must be studied like any other science; skill in them cannot be picked up casually or learnt by trial and error—the man at the bench suffers by the errors. Learn the art and science of management and engineers will be rewarded accordingly.

The trend in education, as indicated by the recent proposals for changes in the school-leaving certificate, by its acceptance of the idea that it is wrong to expect a student to have to work at something he dislikes, is disturbing; it is likely to produce more and more of the narrow specialists, experts in their own line, and bores and a disappointment off it. And they will almost certainly need a protective association.

A. W. Field

Dursley, Gloucestershire, June 2, 1948.

Incorporated Municipal Electrical Association

Final Convention

THE final convention of the Incorporated Municipal Electrical Association was held at Eastbourne from June 7th to 11th in an atmosphere which was admirably expressed, in the words of Mr. J. Eccles, the Association's last President. "After fifty-two years of faithful service to this great industry and its consumers, we meet as an association in annual conference for the last time, not to mourn our fate, not to decry the march of events that has made such a fate inevitable, but, out of the wealth of our experience, and with unlimited good will, to hand on the baton to the new organisations which are now well into their last stride for the next lap."

Certainly there was nothing funereal about the weather, for brilliant sunshine on Monday, June 7th, greeted the official opening by Mr. Eccles of the electrical exhibition in the Winter Gardens, Devonshire Park. Sixty-five firms and associations, representing the British electrical industry, participated in this exhibition, which was organised by the British Electrical Development Association on behalf of the I.M.E.A. On Monday evening delegates to the convention were received in the Winter Gardens by their President, Mr. Eccles, and Mrs. Eccles.

The first session on Tuesday, June 8th, opened with a civic welcome by the Mayor of Eastbourne, Councillor Randolph Richards, J.P., after which Mr. Eccles delivered his address as the last President of the I.M.E.A. Abstracts from this address are reproduced in the last part of this article. The afternoon session was devoted to the discussion of a paper, "Gas Turbines for Public Electricity Supply," by Mr. H. G. Bell (formerly chief engineer and manager, Stretford and District Electricity Board), and Mr. D. M. Smith (chief engineer, gas turbine engineering department, Metropolitan-Vickers Electrical Company, Ltd.). Elsewhere in this issue we reproduce abstracts from this paper. On Tuesday evening there was a reception by the Mayor and Mayoress of Eastbourne.

As an interlude from the more serious business of the convention, Wednesday was set aside for a number of motor coach excursions to Canterbury, Chichester, Tunbridge Wells and Hastings.

Thursday morning's paper, entitled "Reorganisation for Efficiency on a Regional Basis," was presented by Mr. R. C. Golding, formerly borough electrical engineer and manager, Southend-on-Sea electricity department. At the Association's annual dinner on Thursday evening, the principal guest was the Right Hon. Hugh Gaitskell, C.B.E., M.P., Minister of Fuel and Power. A dance held in the Winter Gardens was joined later the same evening by guests at the dinner.

The convention ended on Friday, June 11th, with a morning meeting open to all delegates. This historic meeting included a brief ceremony symbolising the transfer of responsibility for future conventions to the British Electricity Authority and ended with an address by the Chairman, Lord Citrine.

Address by the Last President

In this survey I have attempted to sketch an outline of our industrial past, our present problems and immediate future prospects. It is, of course, conceded that even the main lines have of necessity been but lightly drawn and that many contributory features have had to be omitted. Nevertheless, it is hoped that sufficient has been written to indicate the general course of events and some of the more fundamental causes of our national situation.

Briefly summarised, the facts are: we have increased our population from seven to forty-seven millions in the past 250 years. We have crowded into England and Wales more persons per square mile than there would be in the U.S.A. if the entire population of the world were assembled in the forty-eight States. Over the same period home food production has risen from a subsistence level for seven millions to a full diet for thirty millions. It has been possible to support the additional seventeen millions by drawing upon the stored natural energy of our coalfields and the natural genius of the people, and combining them to produce the things others wished to buy, in return for which they provided us with food, and the raw materials for our industries.

Before the two twentieth-century wars at least 25 per cent of our people were being supported by current activity in trade or commerce with other countries, and 10 per cent by past activities in those fields. As the result of these two wars we have lost the income which sustained the 10 per cent and the income of the 25 per cent is in danger because some countries are striving to be self-supporting in the goods we wish to sell, and those who desire our goods are not always able to supply the things we want in exchange. As the cumulative result of past wars we have amassed a national debt of £22,000,000,000, the interest on which alone requires an annual levy on current productive enterprise averaging £40 per family.

It would be misleading to deny that the position is serious and difficult, or that drastic and, perhaps, novel measures may have to be taken to rectify it, which in the long run may entail a modification in our population and in our mode of living. The phenomenal increase in population from seven to forty-seven millions during the past 250 years has been rendered possible through the unique *rôle* played by our mechanised industry in the expansion of world trade. Now that many countries are becoming mechanised such a *rôle* is unlikely to be repeated. Indeed, it would seem that with the spread of mechanisation even the present primary producing countries will tend increasingly to satisfy their needs by the products of their own factories.

In some countries the tendency may overswing and the inherent output multiplying factor of fully mechanised processes may so outstrip their ability to use the resultant products as to force them to embark upon an export trade.

These activities will be conditioned by the availability of power sources, and, notwithstanding the attractiveness of oil and nuclear fission, coal remains by far the greatest practical source from which industrial power may be derived. The geographical location of the world reserves of this precious material may therefore have some bearing on future trends, as will also the ability of mankind to work in harmony together and preserve world peace. So long as coal is readily available the existence of water power should have only a secondary effect, but in the very long run it may well be that water, inland and tidal, will be the main source of power.

However, such movements are still a long way off, and in the meantime there is much that we can do to secure and retain our share of foreign trade, and to produce more food at home. That this trade will be substantial for many years to come is undisputed. That it will be highly competitive is equally certain.

What is needed for success is the will, the energy and the united effort of all the people, directed by courageous leadership, and disciplined by the stern necessities of the case. Indeed, the spirit in which we tackle our economic problems during the next ten years may settle the status of our island home for the remainder of the twentieth century.

In the past the need has automatically produced the men, but in a society planned to produce the smallest differentials between net rewards, irrespective of the national value of the effort, some new form of incentive will be necessary to induce men of genius and men of courage to give of that superlative best which alone will save us from decline.

For our own industry the path is crystal clear. At workshop level the battle for output will be won or lost mainly by our ability or inability to provide an adequate supply of electric power. In food production we can also lend a helping hand through more intensive rural electrification. To do these things successfully we must hasten forward the greatest programme of capital equipment for generation and distribution that the national economy will permit. Our progress in this respect will be the barometer of Britain's recovery, and may those who control allocations soon find themselves in a position to expedite the rate of construction and commissioning of the scheduled generating stations.

Until full supplies are available, however, there must be a degree of selection with a view to serving the most essential needs first. The effort must also be selective in the economic sense, in that the cheapest and simplest method that is safe and satisfactory should not be lightly turned down for a more elaborate construction that may have been justified in other circumstances. And we must go out for the lead and demonstrate by precept and example, not only the benefits to be derived from a full electrical service, but also that virility of mind and purposeful endeavour which will inspire others to scale new heights in their own terrain.

Thus, as I see it, the interesting drama unfolds on this summer morning 250 years from the date of Savery's invention [of the first practical steam engine].

During the last fifth of that period the members of our Association, and their colleagues in kindred associations, have been building up this great electrical service, which is destined to play such an important *rôle* in shaping the future of our country in a highly mechanised world engaged upon highly competitive trade.

In so doing it may be that we builded better than we knew, or at any rate provided the foundation on which the greater edifice of a prosperous Britain may arise. The associations retire from the field, but the industry marches on, and in the great tasks which lie ahead they wish their successors well.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1.

ELECTRIC LIGHTING IN DWELLINGS

Code 324,101. This Code on "The Provision of Electric Lighting in Dwellings," prepared on behalf of the Codes of Practice Committee by a committee convened by the Institution of Electrical Engineers, has now been published. A draft of the code was published for general comment and was also submitted for specific comment to all professional and trade organisations intimately concerned. All comments and views expressed have been taken into consideration. The code will be revised, if necessary, within a period of five years after publication. The provision of electric lighting in all types of dwellings is dealt with. There are also brief references to the lighting requirements of larger houses, garages and greenhouses and to the modernisation of the lighting system in existing buildings. The code describes the basic requirements in light distribution, giving recommendations for the placing of light sources and prescribing the wattages of electric lamps for use in specific locations and the luminous efficiency desirable for lighting fittings. Minimum general lighting requirements for various types of rooms and supplementary facilities required to provide additional local illumination where necessary are usefully set out in convenient form. The necessity of considering the influences upon lighting efficiency of such matters as interior decoration, deterioration of reflecting surfaces, walls and ceilings, and the ageing of light sources is emphasised. The code is mainly concerned with the installation of tungsten filament lamp, but in view of their growing importance, attention is also directed to the use of fluorescent lamps in appropriate circumstances. An appendix shows a method of determining the size of electric lamps for fixed positions in living-rooms. Price 2s. post free.

A Works Modernisation Scheme

IN the course of its forthcoming Summer Meeting the Institution of Mechanical Engineers will be visiting the well-known firm of hydraulic engineers and founders, Glenfield and Kennedy, Ltd., of Kilmarnock.

The firm was established in 1852, and up to the beginning of this century its works were situated entirely on the west side of the River Irvine. Since 1900 modern and up-to-date light and heavy iron foundries and heavy engineering shops have been built on the east side of the river, and the whole works now occupies an area of some 31 acres. Fifteen acres of this area are covered by workshops. In order to bring the older part of the establishment into line with that of more recent date, the company is now carrying out an extensive modernisation and reconstruction scheme on the shops situated on the west side of the river.

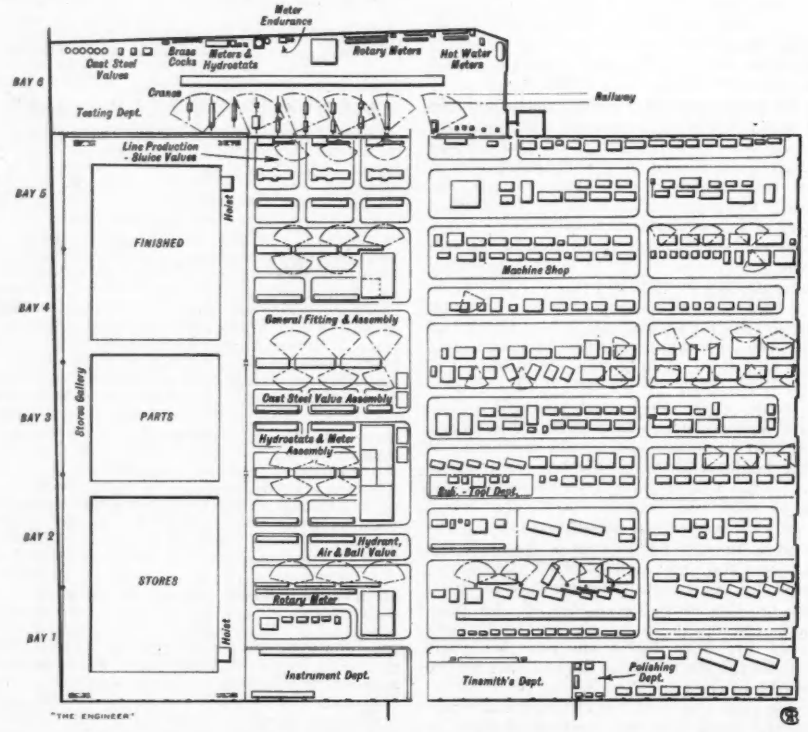
For this programme three large buildings have been completely demolished and in their place a single workshop block embodying the machine, fitting and assembly sections, the test house and a stores, is being erected. The new building has five bays each 60ft wide and 400ft long, together with a test bay on one side 50ft wide and 240ft long. Four of the main bays will have a clear height of 17ft to the underside of the eaves girders. The fourth bay, which will be 26ft high, will serve as a craneway in which two 5-ton electric overhead cranes will operate. Overhead electric cranes will also serve the test bay, which will also be 26ft high.

Designed as a steel-framed skeleton structure, the new building will be bound by brick walls. It will have a concrete floor with a 1in thick granolithic surface. Thirty per cent of the roof area will be glazed and the remainder will be covered with "Ruberoid" steel deck composite roofing. This type of roof consists of a pressed steel sheet reinforced with steel ribs, and covered by an insulation board bituminised to the steel deck and clad and weathered on top with two layers of bitumastic felt.

The ultimate layout of the new building, with its various sections, can be seen in the accompanying drawing. and an impression of one light machine shop bay can be obtained from the photograph we reproduce. The various machine lines are well spaced and separated by clearly defined passages 5ft wide, and a main way 10ft wide separates the assembly and fitting sections from the machines. In assembly areas or at machine points where heavy loads are encountered, hydraulic pillar cranes will be arranged to facilitate the handling of components. The area of the finished parts stores is increased by some 30 per cent by the introduction of a 15ft stores gallery.

The heating system installed is on the steam unit fan heater principle, where fresh air is taken in along the roof area and blown through steam-heated grilles to the floor level. We are informed that sufficient units are being installed to maintain the internal temperature of the building at 60 deg. when the outdoors temperature is 30 deg. Air extraction fans used for ventilation are designed to exhaust the total volume of air three times in an hour. The heating system is thermostatically controlled and means of automatic temperature compensation are provided. The whole building is equipped with fluorescent lighting designed to give a lighting intensity of 10 foot candles throughout.

LIGHT MACHINE BAY



LAYOUT OF NEW BUILDING

Water Pipe Joints in America

A WIDELY discussed subject at the annual meeting of the American Water Works Association was the use of sulphur compounds as a jointing agent for the installation of cast iron water mains. While lead is used more than any other material for water pipe joints, the sulphur compounds are used very extensively in some communities. In the St. Louis area more than 700 miles of pipe of all sizes are jointed with a sulphur compound, most of the joints being over fifteen years old and in excellent condition. At Milwaukee, the compounds were discontinued about 1945, when some of the joints showed pitted action. Estimates indicated that pipe under such action would not last more than sixty years. Some difficulties reported in the use of sulphur compounds were partial failure of the compound after years of service, pitting of the pipe joints and cracking of the pipe bells, in some instances possibly from swelling action. Some failures attributed to such compounds, it was declared, could be charged to soil conditions, electrolysis, poor workmanship, or some unknown factors. The discussion indicated that sulphur compounds as made by American manufacturers had been very effective for water pipe joints for many years, that the cost of jointing was much less than the conventional lead method, that the behaviour of the compounds under some conditions was not well understood.

Laboratory Test Sieve Vibrator*

IN order to meet the need for a mechanical device for the vibration of standard 8in diameter test sieves, the machine described below has been produced, and installed at the Research and Development Department of

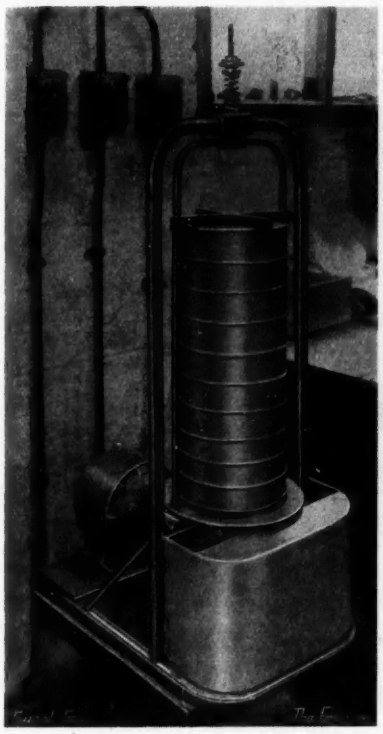


FIG. 1—SIEVE VIBRATING MACHINE

the United Steel Companies, Ltd., Swinden House, Moorgate, Rotherham, for use in connection with ore dressing and other petrological laboratory work.

Of the several machines on the market designed for this type of work, the limiting capacity appears to be from three to six 2in deep sieves, and for the grading of samples into more than six sizes it is necessary for half-size or other non-standard height sieves to be used, or alternatively to carry out the grading in two or more operations of the machine.

Design Conditions.—(1) That the machine be capable of vibrating a nest of up to ten standard 8in diameter, 2in deep test sieves and one bottom collecting pan; (2) That the same vibrating conditions may be reproduced for different tests so that one test may be comparable with another; (3) that efficient grading of the sample may be obtained in the minimum time; (4) that the design be simple to facilitate rapid manufacture in our own machine shop from existing or readily obtained materials.

Construction.—The accompanying photograph reproduced in Fig. 1 and drawing, Fig. 2, show the general arrangement of the machine, which consists essentially of a fixed outer frame supporting an inner moving frame, both frames being mainly of welded tubular construction. The inner frame supports the nest of sieves, the bottom pan of which is located centrally by a retaining ring, whilst the top of the nest is held by means of an adjustable clamp. A rubber disc is cemented to the sieve cover, the normal handle being removed. At the top and bottom of the inner frame concentric vertical spindles are provided, which are located in phosphor bronze bushed bearings in the main supporting frame, with an easy sliding fit. The whole of the weight of the sieves, sample and inner frame is fully floating on a spring located on the top of the main frame, and the inner frame is free to oscillate both about the vertical axis and in the vertical plane.

To the bottom spindle is attached a lever arm which carries a double bearing, supporting a small out-of-balance flywheel. Motion is imparted to the flywheel by means of a length of thick-walled soft rubber tubing coupled to a totally enclosed ½ h.p. electric motor running at 925 r.p.m., rigidly fixed to the outer frame.

For experimental purposes, the radial distance between the flywheel and the axis of the sieves is made adjustable, a slot being provided in the lever arm for adjustment of the position of the flywheel bearings. The adjustable out-of-balance effect in the flywheel is obtained by means of a screw fitted in a drilled and tapped hole running through the flywheel perpendicular to its axis, and locked in position with a small grubscrew. A stainless steel sheet guard is provided to enclose the rotating parts.

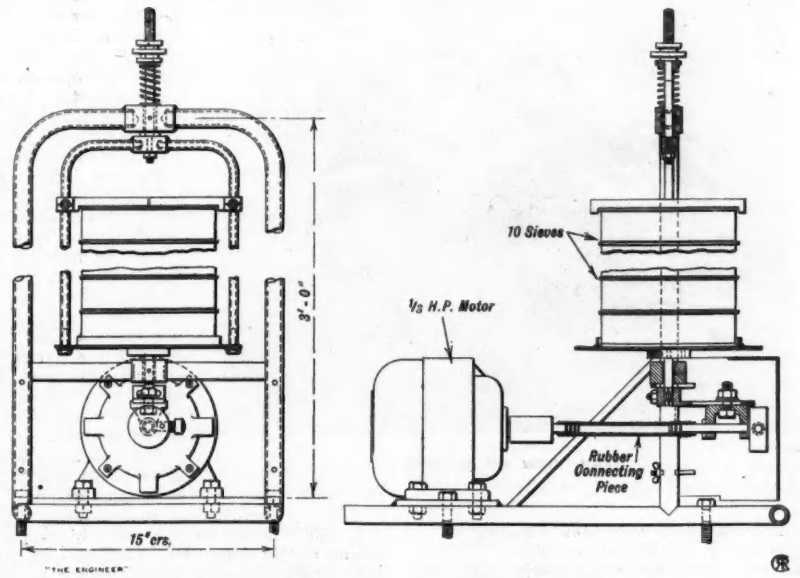


FIG. 2—ARRANGEMENT OF SIEVE VIBRATING MACHINE

Operation.—The centrifugal force generated by the rotating flywheel imparts a vertical vibration to the nest of sieves, and at the same time provides a rotary oscillation about their vertical axis. By adjustment of the out-of-balance weight a condition is obtained in which a point close to the outer edge of the sieve

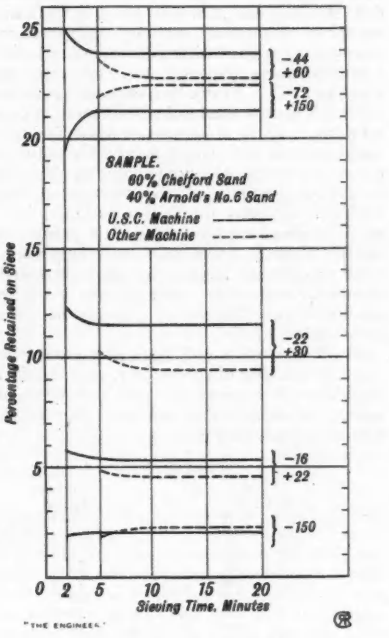


FIG. 3—PERFORMANCE OF MACHINES

mesh describes a circle in the vertical plane, the diameter of this trajectory being approximately $\frac{1}{16}$in, representing the amplitude of the vertical and horizontal vibrations at the edge of the sieves. The vertical movement remains constant across the sieve mesh, the horizontal movement decreasing in amplitude as the centre of the sieve is approached, where the total movement is purely vertical. As a result of this motion the sample is induced to follow a circular path round the sieve.

A more violent action is obtained by the introduction of a rubber washer between

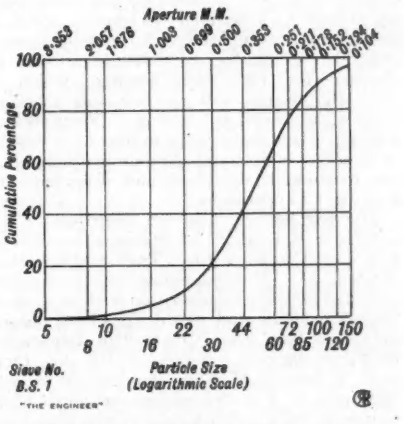


FIG. 4—FINAL GRADING OF SAMPLE

the top of the vibrating frame and the bearing on the fixed frame, and reducing the clearance between the frames. A secondary vibration is set up emanating from the natural frequency of the spring, which results in the frames bumping at this point, with the rubber washer acting as a buffer and silencer. The frequency of this bumping action is readily controlled by adjustment of the suspension nuts above the spring.

Sieving Time and Efficiency Test.—For determination of a "standard" sieving time a

* Communicated by the United Steel Companies, Ltd., Research and Development Department.

100g dried sample comprising 60 per cent Chelford sand and 40 per cent Arnolds No. 6 sand was put through the machine and sieved for two, five, ten, fifteen and twenty minute periods, the amount retained on each sieve being weighed after sieving and the sample being thoroughly mixed each time it was returned to the machine. As a comparison, the same sample was treated in a similar manner on a popular proprietary machine, using half-height sieves. Fig. 3 shows comparative results, from which it will be seen that in the machine described stable conditions were reached after five minutes' sieving, whilst ten minutes were required on the proprietary machine. The generally accepted "standard" sieving time for mechanical vibrators is twenty minutes, and it is suggested that for normal requirements this could safely be reduced to ten minutes with the new machine. The stable condition portions of the curves on Fig. 3 indicate different quantities retained on the same nominal meshes; this is probably due to the fact that the sieves used on the two machines were of different makes and ages, the shallow sieves having to be used on the proprietary machine for capacity reasons as stated previously.

The Table below and Fig. 4 give particulars of the final grading of the sample, and this is also depicted by a curve in which the cumulative percentage retained is plotted against particle size on a logarithmic scale.

Final Grading

B.S.I. sieve No.	Percentage retained
5	0·1
16	5·2
22	5·2
30	11·4
44	18·8
60	23·9
72	12·1
120	18·3
150	3·0
Minus 150	2·0
	100·0

[We understand that the United Steel Companies, Ltd., is willing to make drawings available to any interested parties.—ED., THE E.]

Electrical Resistance Bar Heating Machines

WE have received some particulars of an interesting machine which has been specially designed for applying electrical resistance heating to bars as a preliminary to bending, forming, and forging. Compared with the older furnace methods, a number of advantages can be claimed for resistance heating, which is generally cleaner and quicker and therefore subject to reduced scaling. Furthermore, resistance heating is more uniform and results in economy of fuel and manpower inasmuch as the machine is energised and attended only when it is in operation.

The bar heating machine described in this article is a product of Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester, 17. This particular equipment was intended for use in conjunction with an existing forging machine and was designed for heating mild steel bars from 1¼in to 2⅝in diameter to temperatures in the region of 1000 deg. Cent. over a length of 13in (minimum) to 20in (maximum). For convenience the height of the centre line of the clamping jaws was kept down to 31in, and the overall height of the machine to 39in, giving ample room overhead for slinging the long steel bars which are handled in this shop.

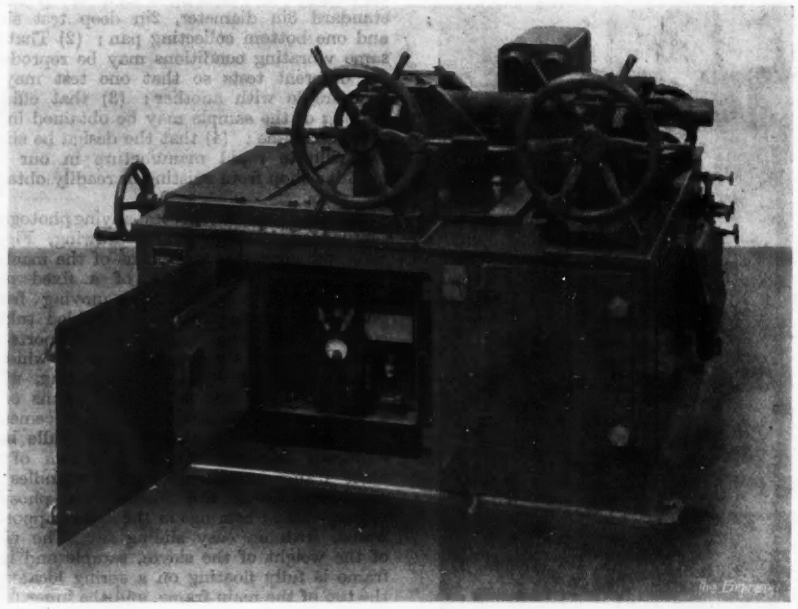
As shown in the accompanying views of the machine, the bars are clamped, for heating, between water-cooled copper blocks, clamping pressure being applied by a screw mechanism operated by handwheels. The length of the bar to be heated can be varied by altering the distance between the two sets of clamps. This adjustment is controlled by operation of the handwheel which can be seen on the left of the machine in our first illustration. To allow for expansion of the bar as it heats up the moving clamps are spring loaded.

Flexible copper rope is used to conduct the heating current to all four clamps, giving a large area of contact with the bar and producing a satisfactory current distribution. The heating current is supplied at mains frequency by a water-cooled transformer mounted inside the fabricated steel frame of the machine. For this particular class of work the use of mains frequency has the important advantage of heating the bar uniformly over its cross section, since the influence of "skin effect" is small at 50 cycles per second. This implies that the outer surface is held at a high temperature for a short time compared with other methods in which heat must be conducted from the surface to the core of the bar. Accordingly, there is a noticeable reduction of scaling when the bar reaches the forging machine.

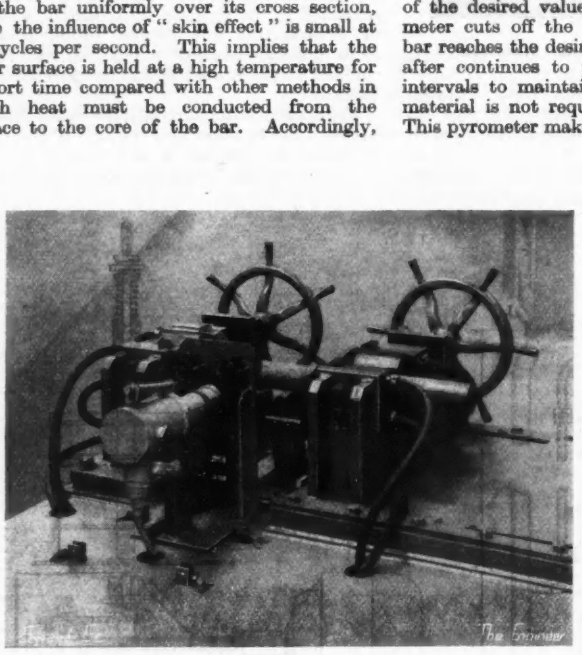
The machine illustrated herewith has two heating rates and the change from one to the other is effected by tap-changing on a link board at the back of the machine. When using the higher speed a 2⅜in diameter steel bar can be heated to 1000 deg. Cent. over a length of 22in in 1¾ minutes, while a 1¼in diameter bar can be heated over a length of 15in to the same temperature in 20 seconds. With small bars, however, it is not always possible to use the higher rate because of overheating at the point of contact with the clamp, especially if the bars are scaled. But even at the lower tapping the smaller bar can be brought up to 1000 deg. Cent. in 50 seconds. In a more recent form this machine incorporates five heating speeds, selected by a five-point tapping switch.

A preset control radiation pyrometer holds the temperature to within ±30 deg. Cent. of the desired value. In operation the pyrometer cuts off the heating current when the bar reaches the desired temperature and thereafter continues to pass pulses of current at intervals to maintain the temperature if the material is not required for use immediately. This pyrometer makes use of a Mazda P.E. 7 B photocell, the resistance of which varies according to the amount of radiation falling upon it. The corresponding variations in cell current are amplified and made to operate the main contactor. A filter fitted in front of the photocell allows nothing but infra-red radiation from the heated bar to influence the cell, and thus eliminates any inaccuracies due to variations in shop lighting intensity. The general view of the machine reproduced herewith shows the door of the pyrometer control panel open. The other view shows the pyrometer unit with its cover removed.

The machine, which is rated at 85kVA, is designed for use on a 400/440-volt, single-phase, 50-cycle a.c. supply, and while actually heating a 2⅜in diameter bar at the maximum heating rate, it takes a line current of approximately 650A. The size of supply cables and protective switch-fuse units are, however, determined by the equivalent continuous current, and a cable having a cross-section area of 0·25 square inch and a switch-fuse unit mounting 350A, H.R.C. fuses are adequate for heating bars at the rate at which they can be handled in this application. If some reduc-



85KVA BAR HEATING MACHINE



REAR VIEW OF HEATER

tion in heating speed can be tolerated, and the machine will only be used on the lower heat setting, a supply suitable for a demand of 300A is all that is necessary.

A supply of cooling water is required for the clamps and the transformer, and at maximum output a total flow of 4½ gallons per minute is necessary. If a cooling tank and circulating pump are used, water can be recirculated, and the only demand on the mains is sufficient water to make up evaporation and leakage losses.

North of Scotland Hydro-Electric Board Loch Sloy Extension and Allt-na-Lairige Scheme

THE North of Scotland Hydro-Electric Board has published two further schemes to develop the water power resources of parts of Dunbartonshire and Argyllshire. One scheme is an extension of the Board's Loch Sloy project (Constructional Scheme No. 1), which, by making fuller use of the water power resources of that area, will provide additional output from the Loch Sloy generating station on Loch Lomondside. The other scheme, situated between the Loch Sloy and Shira projects, is to harness the output of the Allt-na-Lairige by a station built on the left bank of the River Fyne near its junction with the Allt-na-Lairige. The combined estimated cost of the two new schemes is £905,000.

LOCH SLOY EXTENSION

The extension to the Loch Sloy project (Constructional Scheme No. 22) will increase the Loch Sloy catchment area by about 4 square miles, making it total about 31·5 square miles, instead of 27·5 square miles. The total output of the generating station at Inveruglas will be raised to 115 million units, from its present planned figure of 100 million units per annum.

The new sources from which water will be drawn will include tributaries of the Allt Coire Croe, Allt Sugach, Allt A'Bhalachair and certain untapped tributaries of the Inveruglas Water and Allt Arnan. These waters will be led by aqueducts into streams which flow into Loch Sloy. The works cover the construction of five aqueducts, two in Argyllshire and three in Dunbartonshire, at a total estimated cost of £285,000.

ALLT-NA-LAIRIGE SCHEME

The Allt-na-Lairige project (Constructional Scheme No. 27) will utilise the headwaters of the Allt-na-Lairige and some other smaller tributaries of the River Fyne, for the production of 18 million units per annum.

The scheme provides for the construction of a concrete dam 1250ft long and 70ft high across the Allt-na-Lairige, some distance above its junction with the River Fyne to form a reservoir. A generating station to operate under a gross head of 810ft, and with an installed capacity of 5000kW, is to be built on the left bank of the River Fyne about 1 mile below the mouth of the Allt-na-Lairige. The works include the construction of five aqueducts which, with its natural catchment, will give the new reservoir a total catchment of 6 square miles on which to draw.

The output from the station will be transmitted to the Clachan generating station of the Shira project (Constructional Scheme No. 12). The combined output from these stations will go to the Inveruglas sub-station, where it will be added to the output from Loch Sloy and will be passed to the Central Scotland grid in the Glasgow area.

The cost of the works in this scheme is estimated to be £600,000.

In both schemes local labour will be given priority and only when all available labour in the county has been exhausted will workers be brought in from other sources.

Shot-Firing in Coal Mines

THE Institution of Mining Engineers has just issued the second report of its Committee on Shot-Firing and its Alternatives. A Committee on Shot-Firing and its Alternatives issued an interim report, which was adopted by the Council on May 8, 1937. The report covered a wide field and was of value as a record of the practice and ideas current at that time. At a meeting of the Council held on July 18, 1945, it was agreed to reconstitute the Committee for the purpose of bringing up to date the record of the knowledge concerning shot-firing and its alternatives, and a Committee was appointed for this purpose with Mr. T. F. S. Brass as chairman.

The following is a summary of the report.

The advantage of using explosives as a means of lightening manual labour and increasing production, especially from thinner seams, has led to a marked increase in shot-firing. Having regard to the very large number of shots fired, the operation of shot-firing is accompanied by a high degree of safety, and subject to due observance of the Regulations and Orders under the Coal Mines Act, 1911, is not dangerous.

As in the case of the previous report of the Committee, it is necessary to emphasise the importance of proper shelter being taken by persons in the vicinity where shots are being fired.

The experience with sheathed explosives has not entirely fulfilled the expectations which their early promise gave, and precaution continues to be necessary where the presence of breaks in or near shot-holes are suspected. In this connection it would appear to be of advantage to extend the training of shot-firers to enable them to have a fuller understanding of the conditions which govern the safe use of explosives.

Simultaneous shot-firing in both coal and ripping, and the use of gasless delay-action detonators in drifting, have proved successful in increasing the scope of explosives where conditions permit of these methods being adopted.

The increasingly important place which efficiency in the driving of drifts occupies in relation to mining generally leads to the suggestion that consideration might be given to simplifying the procedure whereby the Regulations are relaxed under safe conditions to permit the fullest application of the power of explosives to drifting.

With regard to alternatives to shot-firing, the use of pneumatic picks and Cardox has increased where conditions are suitable.

In spite of advances in the technique of drilling shot-holes, difficulties are encountered which suggest that there is scope for research in this field.

Institute of British Foundrymen*

SOME very important things have happened to our industry in the past twenty to twenty-five years, and foremost I place research, which, I think, can be likened to the Intelligence Branch of an Army. It is the special dimension which enables it "to get there first with the most." In the past we have invested far too little capital in research compared with our international competitors. Maybe we have relied on our craftsmanship and our ingenuity to keep us to the fore, and valuable as these assets are, they are not enough to keep us up to date in these days, where new processes are springing up overnight.

We have the following bodies busily engaged on research, namely :—Iron and Steel Industrial Research Council, the British Cast Iron Research Association, the British Non-Ferrous Metal Research Association. We have the Department of Scientific and Industrial Research, the laboratories of universities, technical colleges and those maintained by private firms. We have all the various technical committees which this Institute sponsors. These bodies are paying dividends and they are going to pay more handsome ones in the future. It has already been said that more could be done by a co-ordinated effort of all these research bodies. Many problems are common to all sections of the foundry industry, and some overriding direction could now be developed with advantage. The somewhat aloof atmosphere of fundamental and specific research could with advantage be tempered to the practical problems of the foundry floor and its production. Our Institute co-operates in various ways with the British Cast Iron Research Association, and it may be that in the near future an arrangement with the Iron and Steel Board and the Department of Scientific and Industrial Research will be made by which all ironfoundries in the United Kingdom will contribute indirectly to the support of this association and become entitled to its services.

* * * *

The advent and commercial production of the modern high-duty irons during the past fifteen years has placed cast iron in the category of a reliable and consistent engineering material. Progress has been so rapid that it has left the engineer and designer years behind in their full appreciation and application of this metallurgical advance. These high-duty irons have raised the whole plane of cast iron to standards far above those which it held a few years ago and the British Cast Iron Research Association can be congratulated for having contributed to this in no small measure.

* * * *

Mechanisation of our foundries has proceeded fast during the past ten years and is playing a great part in increasing man-hour production, eliminating fatigue and reducing costs. With increasing standardisation of our products the tendency has been to extend the mechanisation of the repetition foundries, and so the skill and craft passes from the man to the machine. To-day we have ferrous and non-ferrous die-casting plants making millions of castings every year, and one sometimes wonders where and for how long this output will be absorbed. But remember, away back at the beginning of it all is the skilled moulder, whose craftsmanship is vital and will be needed as long as engineering exists, and this craftsman still works on his knees in the sand in our foundries, as did his ancestors years ago. I leave this thought with our mechanical experts. "Can anything more be done to ease his load and increase his productivity ?"

Much has been said and written on the matter of our foundry amenities and working conditions. The whole subject has been floodlit from end to end, so perhaps very soon that "old-world charm of atmosphere," which has persisted in many of our foundries, will be swept away by the storm of opinion raised by the Garrett Report. The foundry equipment specialists are now vigorously tackling this matter of amenities and working conditions—and there is much to be done.

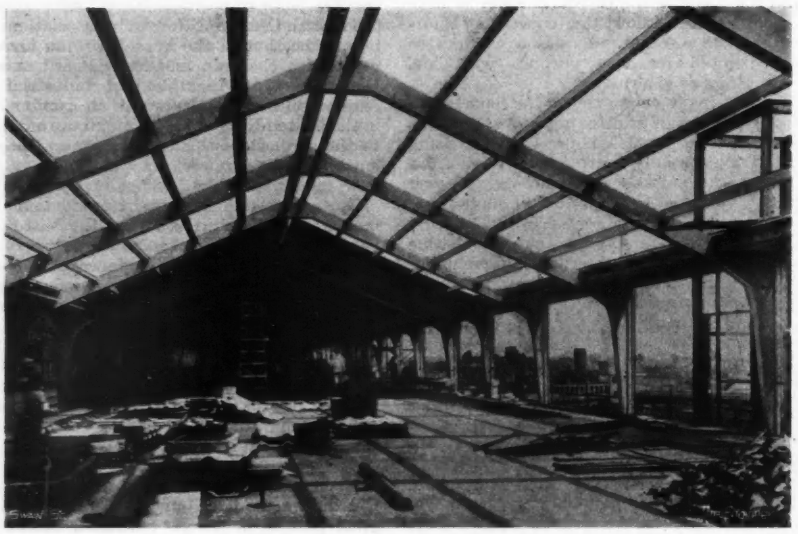
* * * *

I fear, by mentioning the word "concentration," I am stepping in where angels fear to tread, but I do not mean the hurried and muddled form of concentration which was imposed on London foundries with such poor results at the beginning of the war. I think rather of a number of small units where a voluntary merger of their interests and outputs would strengthen them individually and as a group. Take, for instance, five or six small localised jobbing foundries. They each cater for much the same type of casting and customer. They have similar equipment, plant and lay-outs. They compete for orders with each other, and the size of their individual business does not permit of the expense of a cost accounting system. I venture to say that in those five or six foundries many castings are produced in one unit at prices which are uneconomic, but which in another unit of the group would be profitable. A cost accountant would quickly discover anomalies in individual costs and selling prices, and could deploy the group orders in a way which would show better production, greater efficiency and higher profits for each member of the group.

* Extracts from the Presidential Address by R. B. Templeton, M.I. Mech. E. June 9th.

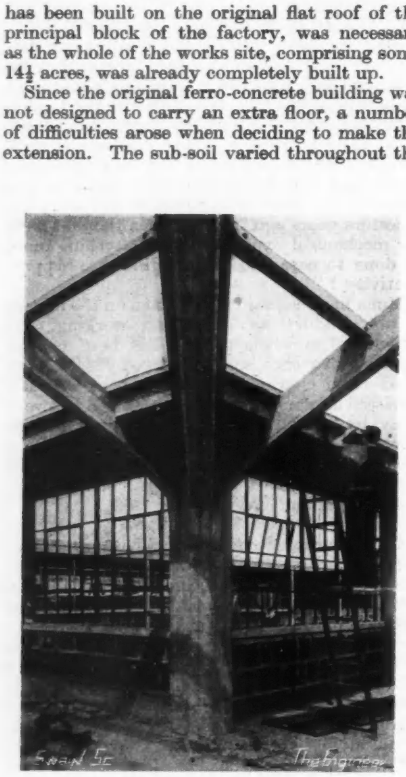
Pre-Cast Concrete Roof Extension

ACCOMPANYING illustrations show a pre-cast concrete top-floor extension to an original three-storey building, which has enabled the Plessey Company, Ltd., of Ilford, to increase its production area by approximately 32,000 square feet. This upwards extension, which has been built on the original flat roof of the principal block of the factory, was necessary as the whole of the works site, comprising some 14½ acres, was already completely built up.



FACTORY ROOF EXTENSION

Since the original ferro-concrete building was not designed to carry an extra floor, a number of difficulties arose when deciding to make the extension. The sub-soil varied throughout the length of the building and difficulty had been experienced with the foundations of the original building. Careful investigations had therefore to be carried out, and it was decided that the only foundations capable of carrying the extra load were those around the outside of the building, for the intermediate columns were fully loaded. The extension therefore had to be formed by the use of single-span trusses, bringing the load on to the main outside columns and the additional structure had to be of very light construction.



ROOF HIP CAST IN SITU

To meet these requirements the trusses were pre-cast in reinforced concrete, cast on the roof of the existing building, and fixed in position by means of dowel holes cut into the existing building columns. The purlins were pre-cast in concrete. Complicated hips were cast in situ by means of shuttering. The sides were formed of 4½in dwarf walls, 3ft high, with continuous steel sashes above, right round the building. Asbestos sheeting was used for the roof, which is lined throughout with Cellotex below the purlins, leaving an air space for thermal insulation.

Fluorescent lighting for the building is installed in three continuous rows in about 2500ft of troughing and comprises 300 80-W tubes, all independently switched. The new floor is served by three lifts.

The main contractors for the work, under the supervision of the Plessey Company's works engineer, were J. T. Luton and Sons, Ltd., Stratford, E.15, while the concrete work was carried out by the London Ferro-Concrete Company, Ltd.

Newcomen Society

SUMMER MEETING AT KING'S LYNN

THE venue chosen for this year's summer meeting of the Newcomen Society was the ancient port and borough of King's Lynn, Norfolk. Situated as it is, where the Great Ouse enters the Wash, it has been the natural gateway to the Midlands for centuries, and in fact during the Middle Ages it was the second port in importance in the kingdom, and a centre for entrepot trade. It has many industries of long standing of interest to technically-minded pilgrims such as the members. They assembled from all parts on Wednesday, June 2nd, the headquarters being the Duke's Head Hotel, a seventeenth-century mansion, 1680, designed by the King's Lynn architect, Henry Bell. The evening was spent in social intercourse.

Thursday was devoted to visits in the surrounding neighbourhood. Making an early start, the road was taken to Hunstanton; the ruins of Castle Rising, and the site of a Roman station, were seen en route. The first stop was at Fring, where the party was met by Mr. Linn Chilvers, who showed them the stills, the only ones of their kind in England, for making lavender essence from the herb, which was a "cry" of London in the seventeenth century. The herb is packed tight in copper stills with perforated bottoms and supplied with reduced steam from vertical boilers working at 70 lb per square inch; the distillate is cooled by a worm circulating water and the oil is collected above the water that comes off. Mr. Chilvers then took the party to the fields at Heacham, where the herb is grown on a seven-year cycle. When ripe, in August, the fields are a blaze of colour and the motto of the firm, "Naturae pulchritudine Deus ipse notatas (God himself is revealed in the beauties of nature)" was realised as appropriate. While at Heacham the corn mill, now disused, built about the middle of the nineteenth century, in a style reminiscent of Gothic, was visited.

Hunstanton was reached for lunch. The first stop after lunch was at Burnham Overy, to see the water-mill dating from 1795, now in the possession of and being reconditioned as a building, by the National Trust and visited by kind permission of the tenant, Mr. R. C. Sherar. Members roamed all over the building and one of them even started up the water wheel, but the chief item of interest was a "whistle mouth" or Butterley Boiler dating probably between 1820 and 1840. This is cylindrical, 15ft long by 4ft 6in diameter, thimble-ring rivetted, externally fired. The upper part is extended over the grate and it has subsequently a crescent-shaped section there; hence its name; it has a single through tube of oval section. Reaching Halkham, tea was taken and the journey back to King's Lynn via Walsingham, Fakenham, Harpley and Hillington, through attractive scenery, concluded the tour. The annual dinner in the evening was honoured by several guests and afterwards there were talks illustrated by epidiascope, lantern slides and blackboard, by N. F. Hilton, M.A., on the "East Anglian Railway Company, 1846–62," the gist of a lengthy thesis; by Rex Wailes, M.I.Mech.E., on "Norfolk Wind and Water Mills," excellently documented; and by Ronald H. Clark, A.M.I.Mech.E., on "West Norfolk Engineering," an eye-opener as to what had been done in this area in the past.

Friday, June 4th, was devoted to visits in King's Lynn itself. Members had to divide into two parties: the first for the more archæologically minded under the guidance of Mr. A. L. Dorer, the local antiquary, visited the churches and the Guildhall, where they saw King John's silvergilt cup, 1327, the regalia and the muniments including charters from Saxon times onwards; then Trinity Guildhall, 1421, and the Hanseatic League's warehouses. The second party, led by Lt.-Col. S. E. Glendenning, D.S.O., M.I.E.E., and Mr. Clark, visited Messrs. Pattrick and Thompson's timber yard by kind invitation of Mr. A. Roland Thompson, to see a beam engine, c. 1847, now a standby but started and stopped for the edification of members. Without seeing a beam engine, no summer meeting of the Society could be complete. As the above engine was fully described in our columns on November 7, 1947, no further notice here is necessary. A Cornish boiler, dated 1871, was seen under steam. An electric lighting plant, now superseded, consisting of a Marshall inverted single-cylinder engine, belted to a Gramme dynamo of unknown vintage, was shown to members.

The King's Lynn Docks and Railway Company was next visited by cordial invitation of the general manager, Ivan J. Thatcher, M.I.C.E., who personally took the party round. The electric dock-side cranes and the hydraulic machinery were of great interest, but a diver getting dressed and descending to work at the dock gates at the entrance, now being replaced, attracted more attention. The next visit was to Messrs. Savage's Nicholas Works, under the courteous guidance of Mr. Stephenson Pilling, managing director. It was a revelation to find what a large share this firm had had in the development of the traction engine and that it was the home of fair-ground machinery of all kinds.

On Saturday morning Mr. Dorer was good enough to conduct the few members who had remained so long over a few of the buildings not visited on the previous day, the principal one being the Greenland Fishery building, a former Mayor's half-timbered mansion, dated 1605, where is preserved the cart-weighing steelyard, one of three still left in the country, formerly used officially in King's Lynn.

Belgium's Contribution to Production Per Man-Hour*

By ROBERT CAUSSIN†

AFTER having considered very broadly some conditions which affected at the start the general problem of production in Belgium in the post-war period, let us now devote some attention to the more technical problem of productivity.

Belgian industry is mainly devoted to semi-manufacture products—metals, textiles, building materials, &c.—which are used as raw materials for more evolute goods. Such products are known as "basic products," and their production, from a method point of view, as "mass production." It is therefore not surprising that Belgium, in this special field, makes a wide use of a special technique of analysis and control of output.

THE THREE FACTORS OF OUTPUT

Essential factors of output can be brought down to three: (*a*) working capacity, (*b*) working speed or intensity; (*c*) duration of work. To ascertain the level reached by the output of work, we must—considering each factor separately—determine the maximum value it can reach in given circumstances; observe the effective value, compare the actual with the maximum output, and figure the relation in order to define the productivity of work. This relation indicates the more or less rational use made of available productive means.

Productive Capacity.—The working capacity of a machine, a man, or any working means can be measured by the volume of material simultaneously handled. It is not infrequent to see working machinery which is not used to full capacity. If such capacity is variable in the course of time, observation extended over a certain period can ascertain the average use and compare it with the maximum use which could have been made. We could, for instance, say that the used capacity is 80 per cent.

Working Speed.—The working speed or intensity usually depends on technical conditions which differ for each kind of work, machine and material. As the maximum speed depends on particular conditions of the work, the basis of comparison to be chosen may be a so-called "normal" working speed, considered as an optimum. If we note the actual average working speed maintained during the working period, it can be compared with what it should have been had the normal speed been maintained all the time. We thus can write: actual working speed, 85 per cent.

Working Time.—Working time is measured in units of time actually devoted to production. The available time includes the number of hours that could have been used for work during the considered time, and can be divided as follows: —(*a*) setting time (loading and unloading, putting the work on the machine and removing it); (*b*) effective work; (*c*) stops.

When we are considering output, the setting time—which is not lost time—may be included either in actual work or in the stops. I, however, prefer this second method.

The relation of the actual working time to the available time will thus appear as, let us say, 70 per cent.

Final Output.—If we now bring close to each other these three factors of productivity, observed from different angles, we note that: (*a*) machinery is only working during part of the available time; (*b*) when it is working, it does not work with full capacity; (*c*) when it works part time and part capacity, its speed or intensity does not reach the normal standard.

The final output being equal to the product of partial results, when we consider the figures we retained as examples, we obtain as final productivity of our machinery:

$$80/100 \times 85/100 \times 70/100 = 47 \cdot 6 \text{ per cent.}$$

We immediately see that as losses of output multiply each other, partial results—apparently satisfactory because expressed with high figures—may very well mask a general situation open to considerable improvement. The final output is valuable to know, not so much as an absolute figure, but because it can only be calculated after a thorough examination of each element. The attention of the observer is drawn not essentially on what is being done, but on the wide difference between what is actually being done and what could have been accomplished. Such a thorough observation has a considerable teaching value and may open the door to efficient reforms.

PRODUCTION LOSSES

The possibility of improving the production figure resulting from our three factors—capacity, intensity and time—appears when it is remarked that our accepted examples are average figures. If we take, among our series of observations, the highest figures, we can see that generally speaking they do not correspond to exceptional performances, but simply to cases in which favourable conditions prevail. The possibility exists for such favourable conditions to be repeated simultaneously for the three factors.

The technique to be followed consists in systematically observing and registering all production losses which occur, and drawing up as complete a list as possible of such losses. The research should be conducted separately for each factor. As the factors "capacity" and "intensity or speed" essentially depend on technical conditions particular for each work, we shall only consider here the factor "time," taking as an objective the finding of remedies for eliminating machine stops.

Systematically registering stops enables us to list the causes and then to study their number, their frequency and their importance. The well-known Gantt chart, with its summary in hours or in money figures, is particularly helpful in such research.

We have to consider separately two kinds of stops:

(*a*) Normal stops: loading and unloading machines, mounting and removing tools, setting operations, lubricating operations, inspection operations, &c.; and (*b*) accidental stops caused by: shortage of orders, shortage of labour, shortage of material, defective material, lack of power, machine accidents, &c.

Classifying all registered stops makes it easy, if we have been careful to note their frequency and length, to begin immediately considering remedies which can be applied to the most important causes of stops, and which are likely to bring most important results. On the whole, after having considered not only how available time is used, but also the use made of capacity and intensity possibilities, production can be improved by two classes of remedies:

(*a*) General remedies, which are:

(1) An attentive preparation of work, (2) a permanent and strict control of the three productivity factors, (3) a compensation system associating executives and labour with the results of production improvement.

(*b*) Particular remedies: Remedies in this class oppose to each cause of output loss the most appropriate counter-measure. These are:

(1) Instructions for the full use of capacity, (2) instructions for supplying machines with material, (3) instructions for complementary work, (4) standardisation of material, (5) standardisation of tools, (6) instructions for working speed and feed, (7) systematical preventive maintenance of machines, (8) supplying spare parts, (9) organising emergency repair squads, (10) organising squad for replacing absent workers, &c.

As can be seen, this technique of analysis and control of the output is absolutely general in its application. It does not afford any original character and can, as a whole, be summed up as "systematic attention brought to every cause of production loss by relation to an ideal 100 per cent output."

GROUP WORKING

A second technique which tends to develop in Belgian industry—especially in fields in which production is more varied and in which our narrow inner market does not warrant mass production—is the technique of what has been called "group working."

The classical idea of assembling in a single shop either machines of the same kind, or similar bench work, is more and more abandoned. On the contrary, *ensembles* are devised—working groups—in which each unit directly contributes to the accomplishment of the assigned work. The former central stores for components are subdivided into supply centres for each department, the principle being to assemble all specific units for each working group in their immediate vicinity.

As regards the work itself, one tries to group together all operations bearing on the same assembly. For instance, in telephone manufacture, instead of preparing all Bakelite moulded parts, or injected metal castings, or electrical windings in centralised departments, decentralised groups are formed in which all the various machine or bench operations are situated at their logical places in their natural sequence in the production process.

Transport simplification, lesser risks of damage to the products and certainty regarding time of delivery are some of the advantages secured in this way. In one case, placing the machines and benches in their logical sequence brought down the working time from fifteen days to fifty-eight minutes.

Further, functional services such as planning, handling, inspection and cost accounting are considerably reduced. In the particular case that has just been mentioned, there is now only one order instead of five, two drawings and two instruction cards instead of two sets of thirteen. Where there formerly were about 52,000 parts in the shops for this type of product, the number was reduced to about 200, owing to this new arrangement of production.

Perhaps it is worth mentioning that this system eliminates indifference of workers regarding the quality of their work, and the feeling that any mistake will be corrected by somebody else. The responsibility of execution becomes thus much more effective. On the other hand, this new arrangement requires group heads to assume greater responsibility and enables them to show individual initiative and capacity far better than in a strictly functional organisation.

It is evident, at last, that a working group formed in this way can be successfully devoted to different products having a similar manufacturing process. Of course, it is more difficult, in such a case, to maintain an absolutely full employment of machines, as differences in working time can alter the work load of individual working places, but advantages obtained in many cases are such that this kind of arrangement is being used more and more.

WORK SIMPLIFICATION

It would be unfair not to mention, among the means that were largely put in use by Belgian industry in the course of recent years to improve working and production conditions, the techniques of process analysis and simplification and motion study.

For the whole of a working process, the observation and simplification of the work with the aid of "process-flow charts" proved particularly useful and fruitful.

In the study of individual work, simplification aims to secure an improved production due to: (*a*) the study of the normal working area of the man, and the best arrangement of material and tools; (*b*) the research and use of the most easy and least tiring motions.

ALUMINIUM RESEARCH LABORATORY.—Aluminium Laboratories, Ltd., of Arvida, Quebec, is to build a new research laboratory for more extensive investigation of problems in the production of aluminium. The laboratory, with which will be incorporated a pilot production plant, is expected to be completed in 1949. The building and equipment is expected to cost approximately one million dollars. The research at Arvida is concentrated mainly on problems in the actual production of light metals, up to and including the extraction of metallic aluminum and magnesium. This involves investigation of the processes used for the chemical treatment of basic ores and other raw materials and for the electro-chemical and electro-thermal reduction of the metals from their oxides.

* Institution of Production Engineers' "Conference on 'P M H'", Wolverhampton, May 22, 1948. Abridged.

† Administrateur-Directeur of the Belgian National Committee for Scientific Organisation.

Industrial and Labour Notes

Import Prices

A statement on the overseas trade returns and the balance of payments was made last week at a Press conference in London by the Chancellor of the Exchequer, Sir Stafford Cripps. In the course of it, he said that the significance of the import figures for March and April was not so much in the actual totals for those months, but in the possibility that the increases might be due to factors of a continuing kind, and in particular to a rise in import prices not matched by a corresponding rise in the prices of our exports. Price changes, an adverse movement in the terms of trade, certainly accounted largely for the fact that the visible deficit in March and April was bigger than in January and February.

Between the end of 1947 and April this year, Sir Stafford explained, the price index for imports rose by 6 per cent and that for exports by only 3 per cent. That tendency had already falsified to some extent the estimates of the overall trade deficit in 1948, which was running at a higher rate than had been forecast, since for the purpose of the forecast no significant change in the terms of trade had been assumed. In circumstances like the present, Sir Stafford continued, it was impossible to foretell world price movements which were influenced by so many fortuitous elements. Two or three months ago there seemed to be a downward tendency in overseas prices, but now it was known that they were still rising, and we might in fact be in the midst of price rises with as yet no firm prospect of stability.

What action would have to be taken in relation to that state of affairs, Sir Stafford said, must depend on the developments of the next few months. The governing factor in the whole situation would no doubt be the American internal price level, which powerfully affected the whole world price level in primary commodities and foodstuffs. If American prices continued to rise, world prices would almost certainly keep in step. On the other hand, there was prospect of a good world harvest, which might have quite an effect upon the level of food prices and so upon other commodities. If, on balance, Sir Stafford concluded, import prices continued to rise and export prices to lag further and further behind them, our import programmes would obviously have to be examined again. It was fortunate, he thought, that our trading arrangements in sterling gave us a valuable margin of time in which to take decisions in an orderly way so as to cause the minimum upset to our industries and our standards of living.

Engineering Wages

It was announced on Tuesday last that the Engineering and Allied Employers' National Federation had rejected the claim for a wage increase submitted in April by the Confederation of Shipbuilding and Engineering Unions. The claim, it will be recalled, was for a national minimum consolidated rate of £5 15s. a week for skilled men, and of £5 a week for unskilled men, and in each case involved an increase of approximately 13s. It was also put forward that piecework arrangements should permit workmen of average ability to earn not less than 20 per cent above the new consolidated rates. The employers' decision, it is reported, was discussed by the Confederation's group council at its quarterly meeting yesterday.

Trade Disputes

In the month of April there were 184 stoppages of work, through industrial disputes, reported to the Ministry of Labour, and there were still in progress in the early part of that month eighteen stoppages which began in March. In these 202 stoppages, 86,000 workers were involved, directly and indirectly, during April, and the aggregate number of working days lost was 619,000. In March, 213 stoppages occurred, involving 62,000 workers and resulting in a loss of 227,000 working days.

Some detailed statistics relating to stoppages of work through industrial disputes in 1947 are published in the May issue of the *Ministry of Labour Gazette*. During the year, 1721 stoppages were reported to the Ministry, compared with 2205 in 1946. The number of workers involved in last year's stoppages through disputes was 622,600 and the aggregate number of working days lost was 2,433,000. An analysis of the causes of the stoppages shows that 807, or 46·9 per cent, arose through wage disputes, and that 527, or 30·6 per cent, related to working arrangements, rules and discipline. Disputes over hours of labour led to eighty-nine stoppages, or 5·2 per cent of the total.

Iron and Steel Production

In spite of the effect of the Whitsun holiday, British iron and steel production maintained its high level during the month of May. Pig iron output averaged 183,700 tons a week, or an annual rate of 9,552,000 tons, and the weekly average production of steel ingots and castings was 292,700 tons, which represents an annual rate of 15,220,000 tons. It is clear, therefore, that, apart from Whitsun week, steel production in May reached a higher rate than any previously achieved.

In the latest issue of the British Iron and Steel Federation's *Monthly Statistical Bulletin* some observations are made on steel output and the export targets. It is pointed out that the record steel outputs, which have made possible the official decision to raise the 1948 production target to 14,500,000 tons, have also enabled the steel-using industries to exceed their export targets. Approximate estimates show that consumption of finished steel for "indirect export" should be at an annual rate of about 1,900,000 tons by the end of this year, which is some 450,000 tons above the actual quantity exported in this way in 1947, and more than twice the 1938 figure.

The increase over the 1947 level in the quantity of finished steel required to meet the end-1948 targets of the consuming industries is equivalent to about 600,000 tons of crude steel. With the high rate of steel production now being achieved, there appears little doubt that this extra quantity can be provided. Indeed, the *Bulletin* says, since exports of the steel consuming industries during the first quarter, which must have been based largely on steel supplied in the latter part of 1947, were already above their target rates, there is good reason to believe that the end-year targets should in general be readily attainable.

The Association of Scientific Workers

The Association of Scientific Workers has now circulated the text of two resolutions passed at the annual meeting of its Delegate Council, which was held last month. The first of the resolutions dealt with the heavy electrical manufacturing industry, and urged that the Heavy Electrical Plant Committee of the Ministry of Supply should be strengthened by increased trade union representation, both from manual and technical unions. Another suggestion made was that production of small motors, transformers and switchgear should be increased by the use of "line-production" methods as employed in the motor-car industry, there being due consultation with the appropriate unions over the new problems arising. Finally, the resolution expressed alarm at the projected cuts in the programme of building new power stations, and the executive committee of the Association was urged to press the Government to reconsider the matter.

The second resolution welcomed the setting-up by the Government of the Industrial Productivity Committee, and pledged support towards the achievement of the maximum scientific effort to assist in the solution of the country's productivity problems. The Council considered, however, that it was equally important to devote scientific effort to improving manufacturing methods in order to reduce production costs; to improving the performance and reliability of the manufactured article; and to conducting consumer research to ensure that what was wanted was being produced. Those tasks, the resolution declared, would place a particular strain on the scientific manpower and equipment at present available for the purpose, and would necessitate an increase in both capital and current expenditure on scientific development, research and education. The resolution set out various suggestions for the redeployment of the country's research services. It also directed the Association's executive committee to re-examine "the question of secrecy in private industry, and the re-establishment of those forms of co-operation and pooling of technical knowledge which functioned during the latter half of the war."

Incentives and Efficiency

The Association of Supervisory Staffs, Executives and Technicians held its thirtieth annual conference in London last week-end, under the presidency of Mr. J. H. Williams. In the course of his address, Mr. Williams urged that there should be more insistence on guarantees of equality of sacrifice from all sections of the community, for without it, he said, a ready response to the call for a greater productive effort from the workers would not be forthcoming.

Mr. Williams also stressed the importance of incentives in industry, saying that workers desired adequate wages or salaries and reasonable working conditions, and that they desired, too, to be consulted in relation to the operation of the establishment in which they were employed. In addition, employers needed some incentive, for it was useless to tax them out of existence and at the same time expect helpful response from them. Management, Mr. Williams continued, wanted some incentive—so far it had had nothing but abuse—and it needed some recognition of its functions and, what was even more important, it wished to carry out its job on scientific lines with co-operation from employers and workers. A position of economic security and stability could only be established if it was admitted that as long as there were employers on one hand and workers on the other, they must be provided with the incentive to co-operate for the greatest good of the country as a whole and not for any one section. The first step in that direction, Mr. Williams considered, should be through the medium of joint consultative committees, for consultation led to co-operation, and co-operation to confidence.

Finally, Mr. Williams had a word to say about the higher standard of efficiency through management, which he thought was urgently needed. It concerned, he asserted, the whole field of executive and supervisory functions, and he was glad that the British Institute of Management had been established. The first reports of the activities of that Institute were, he said, encouraging, and provided it followed a realistic line in laying down management standards, nothing but good could come from its work. He felt, however, that it was necessary to utter a word of warning, and he asked the Institute "to keep its feet on the ground." Whilst technical qualifications were necessary, the hard school of experience also counted for a great deal, and the ability to handle men was equally as important as the ability to handle machines. If that lesson was kept in the forefront, Mr. Williams concluded, the British Institute of Management should prove of considerable value to industry and to the nation.

French Engineering News

(From our French Correspondent)

Steel reserved for agricultural production has increased considerably from 133,000 tons for the last quarter of 1947 to 198,000 tons for the second quarter of 1948. Of this figure, 98,000 tons are reserved for the agricultural machinery industry, which will now be able to work to full capacity. Up to now the greatest effort has been concentrated on tractors, the allocation increasing from 4300 tons in 1938 to over 72,000 tons in 1947. Because allocations of steel have been insufficient, other agricultural machinery has been neglected in favour of tractors, but in 1948 production of implements, &c., will be brought into better balance.

* * *

Following the results obtained in the Pyrénées by the Régie Autonome des Petroles, which produced 170,000,000 cubic metres of combustible gas in 1947, the possibility of further tapping of the natural gas resources in the Alps is being considered. A rough prospection has shown the presence of combustible gas in the Gresse Valley, at Chatillon, at Moliere-Glandaz (Drome), at Nyons, and in other areas. The sources of natural gas in the Alpine zone are deemed to be sufficiently numerous to justify future prospection.

* * *

French coal supplies for May will amount to 2,218,800 tons: 1,547,000 tons from the U.S.A., 349,300 tons from Germany, 120,000 tons from Great Britain, 127,050 tons from Poland, 54,600 tons from Belgium, 12,550 tons from Holland, 2000 tons from Czechoslovakia, and 6300 tons from Morocco. Only 1,033,982 tons were received in April out of the 2,075,500 tons expected, mainly due to American coal strikes.

* * *

Following a recent Assembly, the report of the Construction, Repair and Rolling Stock Chambre Syndicale has just been published. It discusses the need to establish priorities in construction and points out that although the Plan for Modernisation and Equipment makes transport a priority, construction of means of transport are not. This has led to bottlenecks, for example, in steel plants, which cannot deliver, due to lack of transport, while rolling stock constructors are held up for lack of steel.

In order to fulfill the S.N.C.F.'s ten-year programme, 2,146,572 tons of ferrous metal are needed. The programme should have started two years ago, with, if possible, extra effort in the first years to satisfy the more urgent needs, but orders placed since the Liberation represent only 185,306 tons or 43 per cent of planned provisions, and metal licences allowed for these orders amount to 118,415 tons, or 28 per cent of provisions. Also, there is a delay of eighteen months between the receipt of licences and the actual supply of the metal.

The constructors complain that concentration and specialisation of the industry is planned by the State, which will lead to the elimination of many firms now producing rolling stock, and also to specialisation by others, which will limit their activities so considerably as almost to eliminate them, too. Although the motives seem laudable, the industry claims that the initiative and responsibility should be left to the industry itself. State interference at this point, say the constructors, will only lead to the nationalisation of yet another branch of French industry. The report of the Modernisation Plan is quoted as saying that only after 1948 can the question of modernisation of industries supplying means of transport be considered. The constructors claim that only the number and variety of installations at present existing have enabled the variety of orders placed by the railways to be fulfilled. Moreover, concentration, it is contended, would have little bearing on prices, leading mainly to over-equipment of plants on the American style, which would not be paying, taking into account French requirements and capacity.

Notes and Memoranda

Rail and Road

THE CHENGTU-CHUNGKING RAILWAY.—It is reported from China that two-thirds of the 330-mile Chengtu-Chungking Railway is now in working order. Work began on the railway before the war, but owing to the fact that necessary materials had not been shipped before the enemy blockade of the Yangtze, construction had to be suspended. Construction was resumed in the winter of 1946, and fourteen tunnels have been completed, another thirteen are in course of construction and 640 bridges and 1200 culverts have been built. The railway is standard gauge and there are hopes that the line will be completed by the end of 1949.

LONDON TRANSPORT RAILWAY BRIDGES.—London Transport announces that two bridges on the Hammersmith and City line are to be built alongside the railway tracks and rolled into position overnight. The bridges are near Ladbroke Grove, and will replace the existing bridges spanning Portobello Road and St. Mark's Road. A prefabricating method will be adopted to avoid interruption of the heavy traffic on the line, and the steelwork will be assembled on temporary staging beside the track. The floors will be concreted and the rails laid in place, and when all is ready they will be moved sideways into position on rollers. One bridge, complete for rolling, will weigh 150 tons, and the other will be in two sections, each weighing 75 tons. The work will be begun later this year and is expected to take six to seven months to complete.

RAILWAY TRACK RENEWAL PROGRAMME.—British Railways have authorised a programme of permanent way works during this year involving the complete renewal of 1226 miles of track and a partial renewal of a further 550 miles. It was originally hoped that during 1948 it would be possible to overtake some of the arrears of renewal which had accumulated during the war years, but the present economic position has prevented that. It is, however, expected that it will be possible to complete the whole of the mileage programme estimated to be done during the year, thereby enabling some of the temporary speed restrictions to be lifted. The greatest possible use is being made of the prefabricated method of track relaying. New sections of track up to 60ft in length are assembled beforehand and taken out to the site of the work. There, by means of cranes, sections of the old line are lifted complete and loaded on to trucks, and the new sections of track are dropped into position.

Air and Water

INSTITUTION OF NAVAL ARCHITECTS.—The autumn meeting of the Institution of Naval Architects is to be held in London from Tuesday to Friday, September 21st to 24th. The mornings of the first three days will be given up to the reading and discussion of papers at the Royal Society of Arts, Adelphi, W.C.2, and in the afternoons visits will be made to works and other places of interest in the London area. On Friday, September 24th, alternative whole-day visits are being arranged to the Royal Aircraft Establishment, Farnborough, or the works of the Northern Aluminium Company, Ltd., Banbury.

"SAILING SHIPS" CATALOGUE.—A third edition of "Sailing Ships: Part II, Catalogue of Exhibits, with Descriptive Notes," revised and enlarged by Mr. E. W. White, A.M.I.N.A., has been published by H.M. Stationery Office, price 3s. 6d. Copies may be obtained from the Science Museum, South Kensington, London, S.W.7, or from H.M. Stationery Office. The volume, consisting of over 300 entries, includes concise descriptions with dimensions and other interesting information concerning the large collection of magnificent ship models, draughts, &c., which the Science Museum has acquired from many sources, to form the basis of a visual history of marine architecture and navigation.

Miscellanea

THE LATE MR. A. T. GILLANDERS.—We have learned with regret of the death, on May 25th, of Mr. Alexander Thomas Gillanders, who, until his retirement in 1942, was power cable manager of Standard Telephones and Cables, Ltd. Mr. Gillanders joined the staff of that company in 1902.

EXHIBITION OF MACHINE TOOLS.—An exhibition of machine tools and equipment is being arranged by Alfred Herbert, Ltd., to be held at 103, Whiteladies Road, Bristol, 8, from June 21st to 26th. It will be open each day from 10 a.m. to 6 p.m., and will include the latest types of machine tools, measuring instruments and machine shop equipment produced by the firm.

IRON AND STEEL DISTRIBUTION.— A booklet entitled "Notes to Consumers," which deals with various aspects of the iron and steel distribution scheme, has been published by H.M. Stationery Office, price 6d. It gives the names and addresses of authorising departments, with details of their authorising responsibilities, and the items that are covered by direct authorisations.

INSTITUTION OF MINING AND METALLURGY.—The Gold Medal of the Institution of Mining and Metallurgy, the highest distinction which the Council has power to grant, has been awarded to Mr. G. Carleton Jones, resident director in South Africa of New Consolidated Gold Fields, Ltd., in recognition of his distinghished services to the gold mining industry of South Africa, and in particular to the development of the West Rand.

THE LATE MR. JULIUS VEIT.—We have learned with regret of the death, on May 30th, of Mr. Julius Veit, A.M.I.E.E., general manager of Duratube and Wire, Ltd., Feltham. Mr. Veit, who was fifty-five, was a fellow of the Plastics Institute, and had for many years specialised in the application of P.V.C. insulation for wires and cables and other electrical products. He founded Duratube and Wire, Ltd., in the early days of the war and contributed to the solution of many technical problems in the production of wires and cables for special wartime requirements.

IRON AND STEEL INSTITUTE.—The Iron and Steel Institute announces that the seventh meeting of the Iron and Steel Engineers' Group will be held at 4, Grosvenor Gardens, London, S.W.1, on Tuesday, June 22nd, at 10.30 a.m. At the morning session papers will be presented by Mr. R. A. West on "Electric Control Gear for Steel Mill Auxiliaries," and by Dr. W. G. Thompson on "Electronic and Servo-Electronic Controls and their Application to the Iron and Steel Industry." At the afternoon session, beginning at 2 p.m., Mr. G. S. Martin and Mr. M. Y. Harvey will read a paper on "The Maintenance of Electrical Machinery in Iron and Steelworks."

MARINE RADAR SPECIFICATIONS.—In consultation with representatives of shipowners, ships' officers, lighthouse and harbour authorities and marine radar manufacturers, the Ministry of Transport has recently reviewed the standards laid down in the U.K. Performance Specification for a General-Purpose Radar Set for Marine Transport (November, 1946). Accordingly, a booklet entitled "Marine Radar: Performance Standards," containing the new marine radar performance specification, 1948, which supersedes all previous U.K. specifications for mercantile marine radar equipment, has been published by H.M. Stationery Office, for the Ministry of Transport, price 4d. The booklet also includes a "List of Additional Facilities," which is intended to acquaint users with some of the extra features and ancillary devices which can be made available in radar sets, and a "List of Recommended Practices," intended to draw attention to various aspects in design, which, although not obligatory for the issue of a Certificate of Type Testing, should be borne in mind in judging a particular radar set.

CONVEYOR BELTING.—The National Coal Board last week issued a statement about its orders for conveyor belting. It explained that last year it started a short-term programme to put in belt conveyors underground as widely as possible. This was a first instalment of general haulage reorganisation, and one of the objects of the scheme was to free haulage workers for upgrading to more productive work at the coal face. A quick estimate of the requirements of belting for the ensuing twelve months was on the generous side, amounting to 13,500,000ft. United Kingdom production of belting available to the Board for the first six months of 1947 was under 4,000,000ft, and to cover the probable deficiency from home sources over the rest of 1947 and 1948 the Board ordered 2,000,000ft from the United States. By the end of 1947 deliveries of belting to the Board had increased to the annual rate of some 10,000,000ft; forward estimates of belting production were rising, and the introduction of conveyors into the pits was not going forward as fast as had been hoped. The exact figure of British belting likely to be available to the Board is still under discussion with the British manufacturers, but for some time it has been clear that requirements from America were over-estimated. The Board accordingly asked the American manufacturers to reduce the outstanding contracts, and some have agreed to do so. The Board is taking delivery of the remaining U.S. contracts, amounting to 1,900,000ft and costing about 4 dollars a foot, spread over 1948 and 1949. Belting available in advance of requirements will probably be acquired and put into stock until needed.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Supervising Electrical Engineers

Wednesday, June 16th.—KENT BRANCH: Royal Star Hotel, Maidstone. "Fluorescent Material and Colour Vision," H. W. Windebank. 7.30 p.m

Belfast Association of Engineers

Wednesday, June 23rd.—Visit to Belfast Airport, Nutt's Corner, Crumlin. 7 p.m.

Incorporated Plant Engineers

Wednesday, June 16th.—WESTERN CENTRE: Grand Hotel, Bristol. "Factory Buildings," E. O. James. 7.15 p.m.

Institute of British Foundrymen

To-day, June 11th.—Annual conference in London. Conference office at Café Royal, Regent Street, W.1.

Institution of Gas Engineers

To-day, June 11th.—Friends' House, Euston Road, London, N.W.1. Annual general meeting.

Institution of Heating and Ventilating Engineers

Monday, Tuesday and Wednesday, June 21st, 22nd and 23rd.—Burlington Hotel, Boscombe, Bournemouth. Summer meeting.

Institution of Mechanical Engineers

Tuesday, Wednesday and Thursday, June 15th, 16th and 17th.—Glasgow summer meeting.

Institution of Mining Engineers

To-day, June 11th.—Neville Hall, Westgate Road, Newcastle-upon-Tyne. Summer meeting.

Institution of Mining and Metallurgy

Thursday, June 17th.—Geological Society, Burlington House, Piccadilly, W.1. "Impressions of Mining Practice in North America," Jack Spalding. 5 p.m.

Iron and Steel Institute

Tuesday, June 22nd.—4, Grosvenor Gardens, London, S.W.1. Iron and Steel Engineers' Group meeting. 10.30 a.m.

Catalogues

T. C. JONES AND CO., Ltd., 10, Wood Lane, London, W.12. Folder dealing with engineers' small tools and power transmission equipment.

INTERNATIONAL COMBUSTION, Ltd., 19, Woburn Place, W.C.1. Pamphlets dealing with drags, scrapers and skip hoists, and material handling.

J. SAMUEL WHITE AND CO., Ltd., 41, Whitehall, S.W.1. Booklet dealing with oil-fuel-burning equipment for marine and industrial boilers.

STEELS ENGINEERING PRODUCTS, Ltd., Technical Department, 6, Avonmore Road, Fulham, W.14. Leaflet describing Coles mobile cranes.

SAUNDERS VALVE COMPANY, Ltd., Cwmbran, Newport, Monmouthshire. Publication dealing with applications of the Saunders diaphragm valve.

INTERNATIONAL MEEHANITE METAL COMPANY, Ltd., 66, Victoria Street, S.W.1. Booklet entitled "The Specification of Meehanite Metal."

DAVIDSON AND CO., Ltd., Sirocco Engineering Works, Belfast, Northern Ireland. Illustrated catalogue describing the "Aeroto" mine fan.

FEDERATION OF COATED MACADAM INDUSTRIES, 37, Chester Square, S.W.1. Brochure entitled "The Advantages and Uses of Coated Macadam."

B.E.N. PATENTS, Ltd., High Wycombe, Bucks. Illustrated leaflets on the B.E.N. range of spray painting guns and spray finishing equipment.

PHILIPS ELECTRICAL, Ltd., Century House, Shaftesbury Avenue, W.C.2. Publication A.163, describing fluorescent industrial lighting fittings.

DARGUE BROTHERS, Ltd., Simplon Works, South Street, Halifax. Folder dealing with "Simplon" universal drafting machines and tables.

HENRY WIGGIN AND CO., Ltd., Grosvenor House, Park Lane, W.1. Notes on "The Properties and Applications of Nickel and Nickel Alloy Products."

CONSOLIDATED PNEUMATIC TOOL COMPANY, Ltd., 232, Dawes Road, London, S.W.6. Catalogue No. 203, covering the full range of Duff Norton jacks.

GLOBE PNEUMATIC ENGINEERING COMPANY, Ltd., High Road, Chadwell Heath, Romford, Essex. Leaflets dealing with pneumatic hoists, winches and air-operated cylinders.

THE CHURCHILL MACHINE TOOL COMPANY, Ltd., Broadheath, Manchester. Booklet giving brief details of all standard types of Churchill precision grinding machines.

MARCO CONVEYOR AND ENGINEERING COMPANY, Ltd., Rowin Works, Lynn Road, Leytonstone, E.11. Illustrated catalogue dealing with mechanical handling equipment.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, Ltd., 51 and 53, Hatton Garden, E.C.1. Booklet giving details of the Henley rising main system, and illustrated catalogue of rubber cables.

Personal and Business

MR. W. E. BALLARD has been elected President of the Birmingham Metallurgical Society.

MR. PETER WRIGHTSON has been appointed a director of Head, Wrightson and Co., Ltd.

MR. L. SCOTT WHITE, M.I.C.E., has been elected President of the Institution of Structural Engineers.

DR. JAMES M. MCNEILL and Mr. Eric Mensforth have been elected directors of John Brown and Co., Ltd.

MR. H. A. LONGDEN has been appointed Production Director of the North-Eastern Divisional Coal Board.

MR. J. N. STEPHENS has retired from the position of assistant to the chairman of Associated Electrical Industries, Ltd.

MR. J. MCBRYER, B.Sc., has been appointed sales manager of Russell Newbery and Co., Ltd., Dagenham, Essex.

MR. C. E. EDWARDS has been appointed sales manager of the Appleby-Frodingham branch of United Steel Companies, Ltd.

THE NORTHERN ALUMINIUM COMPANY, Ltd., states that the telephone number of its head office and London sales office is now Temple Bar 8430.

DR. NORMAN SWINDELLS has been appointed chief metallurgist at the Birmingham works of McKechnie Brothers, Ltd.

MCKECHNIE BROTHERS (SOUTH AFRICA) (PTY.), Ltd., announces that its address is 42–43, Rendell Road, Wadeville Industrial Sites, Germiston, Transvaal.

CLARKE AIRCRAFT PRODUCTS, Ltd., Derby, has been acquired by the Braid Group and renamed Braid Engineering, Ltd. Mr. A. G. Clark has been appointed managing director and Mr. L. H. Williams sale director.

PEARSON PHILLIPS, Ltd., 194–196, Finchley Road, London, N.W.3, has been appointed sole distributors for the products of L. Schuler A/G., Göppingen, Wurtemberg, Germany.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., announces that Mr. J. P. Cranmer, M.I.E.E., has been appointed Midlands area engineer, with headquarters at the Birmingham district office.

THE FEDERATION OF BRITISH INDUSTRIES announces the appointment of Mr. K. J. Webb as Nottingham District Secretary, in succession to Lieut.-Colonel G. W. P. Dawes, who has retired.

THE INSTITUTION OF CIVIL ENGINEERS announces the following elections:—President, Sir Jonathan (Roberts) Davidson; Vice-Presidents, Sir Reginald Stradling, Mr. V. A. M. Robertson, Mr. W. H. Glanville and Mr. A. S. Quartermaine.

LIEUT.-COMMANDER R. B. FAIRTHORNE, R.N. (Ret.), M.I.E.E., has been elected President of the Institution of Engineering Inspection. He is the principal Production Officer in the Directorate of Royal Ordnance Factories, Ministry of Supply.

THE LONDON MIDLAND REGION OF BRITISH RAILWAYS announces the following appointments:—Mr. E. R. Brown, assistant works manager, Crewe locomotive works; and Mr. J. Sinclair, assistant works superintendent, Horwich locomotive works.

THE ALUMINIUM WIRE AND CABLE COMPANY, Ltd., has transferred to its Swansea works the manufacturing facilities for aluminium and alloy wire and hot-rolled rod hitherto operated by the British Aluminium Company, Ltd., and Reynolds Light Alloys, Ltd. Sales of wire and rod made at Swansea will continue, for the present, to be handled by the British Aluminium Company, Ltd., but will be taken over by the Aluminium Wire and Cable Company, Ltd., in a few months' time.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of report	Title	Post free s. d.
F.I.A.T.:		
T/B T–30 ...	Compact High-Efficiency Alternating Current Rectifier	3
T/B T–32 ...	Production of Bearings by Extrusion Methods	3
T/B T–34 ...	Adsorption of Low Boiling-Hydrocarbons by Activated Carbon	3
T/B T–43 ...	Distyrol	3
T/B T–44 ...	Water Repellent for Rayon Staple Fibre	3
B.I.O.S.:		
116 (Supplement)	Interrogation of Professor Schaumann on N- (Y: Y-Diphenylpropyl) Piperidine, "Aspasan" and Analgesic Testing	1 7
1047	German Acetylene Chemical Industry: Generation of Acetylene from Carbide	6 2
1429	Modern German Switchgear Practice	25 5
1607 (and Supplement) ...	Report on the Safety Aspects of Mining Methods and the Training of Mining Personnel in Germany and Holland ... ... The report and supplement will not be sold separately	38 2
1653	German Oil-Burning Devices Industry	4 2
F.I.A.T.:		
1141	Synthetic Detergents and Related Surface Active Agents in Germany	11 3
B.I.O.S.:		
Misc. 62 ...	Anti-Fouling and Anti-Corrosive Paints Used by the German Navy	1 1
394	Technical Report on the Ruhr Coalfield, Volume III, Appendix 26: The Efficient Utilisation of Shaft Space...	2 9
985	The Separation of Methane and Ethylene from Coal Gas	3 2
1566	The Manufacture of Condensers, High-Voltage Bushing Insulators and Laminated Electrical Insulation at "Dielektra" A.G., Porz-am-Rhein	2 1
1601	The Design of Industrial Furnaces in Germany (British zone)	17 10
1644	Manufacture of Sulphuric Acid, Chemische Fabrik Wesseling A.G., Wesseling Bei Koln	2 1
1697	Synthetic Oil Production in Germany: Interrogation of Dr. Butefisch	3 2
1700	The Manufacture of Glycerophosphates and Hypophosphites in Germany	3 8
1703	Manufacture of Aluminium at I.G. Farben Factory, Bitterfeld	2 1
1708	Production of Butane- 1 : 2 : 4-Triol at I.G. Ludwigshafen ...	4 8
1710	Manufacture of Tube Turns and Fittings and Details of Roeckner Radial Rolling Mill	1 7
F.I.A.T.:		
T/B T-29 ...	Some Properties of Silicon and Titanium Stainless Steels	0 3
T/B T–47 ...	Electrical Grades of German Plastics	0 3
B.I.O.S.		
Misc. 61 ...	Aircraft Vibration and Flutter Research in Germany	6 2
Misc. 63 ...	Refining of Light Oil from Coal Gas	2 1
JAP/PR/1664	Pyrite Resources of Japan ...	2 1
394	Technical Report on the Ruhr Coalfield, Volume III, Appendix 12: Modern Machines for Coal Extraction	1 1
1170	Railway Main Line Booking Office Ticket Printing Machines	5 8
1606	Progress in Microchemistry in Germany	5 8
1725	Synthetic Aromatics, Perfumes, Isolates and their Derivatives ...	9 3
F.I.A.T.:		
1054	German Design Practice for Large Dry Type Gasholders: An Evaluation	12 3
B.I.O.S.:		
Misc. 25 ...	The German Soap Industry ...	5 2
Misc. 26 ...	Production of Synthetic Fatty Acids	3 2
Misc. 67 ...	Hydraulic Couplings for Marine Main Drives	3 1
JAP/PR/1584	The Japanese Wartime Standard of Living and Utilisation of Manpower	13 3
JAP/PR/1665	Molybdenum in Japan	2 8
394	Technical Report on the Ruhr Coalfield, Volume III, Appendix 2: Planning a New Area... ...	10
1712	Medium Pressure Synthesis with Iron Fixed-Bed Catalysts, and Operation of the Fischer Tropsch Synthesis in the Liquid Phase, Interrogation of Dr. H. Kolbel	1 1
1715	Synthetic Resin Emulsions and Cellulose Lacquers, Interrogation of Dr. A. Kraus	2 8
1720	Dicyandiamide Production ...	3 8
F.I.A.T.:		
672	Air and Oil-Cooled Adam Opel 72 h.p. Truck Engine	4 2
J.I.O.A.:		
41	The Production of Suprifen at Farbwerke, Hoechst, Germany	1 1
B.I.O.S.:		
JAP/PR/1593	Age Hardening of Metals	1 1

B.I.O.S. 1661: An erratum to this report has been issued and is available at the Sales Offices of His Majesty's Stationery Office.

Technical Information and Documents Unit, German Division, Board of Trade, 40, Cadogan Square, S.W.1, which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

A Seven-Day Journal

Institution of Metallurgists

THE annual meeting of the Institution of Metallurgists took place at the home of the Institution in London on Thursday, June 10th. In his remarks the retiring President, Dr. J. W. Jenkin, made reference to the highlight of last year, the refresher course held at Derby last September. He announced that a second course is being arranged for next autumn at Ashorne Hall, near Leamington, on the mechanical working of metals. With regard to Dr. Arthur D. Merrington, the Registrar-Secretary, he said that he came to the Institution at the height of a distinguished scientific and military career, and he would have the advantage of Dr. Harold Moore's advisory services and those of Mr. Headlam Morley in the transfer of secretarial duties. He welcomed the new President, Dr. Maurice Cook, as a metallurgist of the highest standing, who held a very responsible post with the Metals Division of Imperial Chemical Industries, Ltd. He had wide administrative experience in various metallurgical councils, and he committed the Presidency into his hands with unlimited confidence in the future of the Institution. In his Presidential Address Dr. Cook dealt with the history of the Institution at some length and said that it had already become in a very full and real sense representative, and should be recognised by the Government and other organisations and bodies as the contact between them and the metallurgists of the country. He spoke of the Institution's *Bulletin* and expressed the hope that it could be enlarged and made into a publication of great value and interest. He then went on to deal with the problems of membership, stressing the need for maintaining a high standard of metallurgical competence as a qualification for admission. In his closing remarks Dr. Cook said that if we had any awareness at all of realities, we must appreciate that in this seemingly bedevilled world of ours the major problems of to-day were not material, but idealistic and of the spirit. He had spoken of the importance of motives and ideals, because he felt that only if these were of the highest we should merit and achieve success. On such a foundation the Institution could, with united enthusiasm and growing strength, face the future with every confidence. The word "noble" was not unfamiliar in metallurgy; let us, by worthy endeavour, earn it for the profession.

Instructional Courses in Servo-Mechanism

FEELING that the fundamental principles of servo-mechanism or automatic control have been neglected in engineering training, the Inter-departmental Technical Committee of Servo-Mechanism has secured the co-operation of the Ministry of Education, the Scottish Home Office and various educational institutions to establish courses and to train instructors. The courses so far scheduled for this year are:—Heriot Watt College, Edinburgh, June 15th to 18th; Central Technical College, Birmingham, July 5th to 9th; Northampton Polytechnic Institute, London, July 12th to 16th; Central Technical College, Birmingham, August 30th to September 4th; King's College, Newcastle-upon-Tyne, September 1st to 3rd. Further particulars can be obtained from these establishments. The courses will include lectures on basic principles, general applications and applications of particular local significance. It is hoped at a later date to organise similar courses in other important centres. The Technical Committee consists of experts drawn from the various universities, Government research establishments and large industrial organisations. All the administrative work is being carried out by the Ministry of Supply's Directorate of Weapon Research. The prime object of this technical committee is to act as a co-ordinating link between the research side of this science and its practical applications. Up to the present one of the greatest obstacles to the furtherance of automatic control has been the lack of people sufficiently conversant with the subject to be able to teach it, either in elementary or in post-graduate courses. The first step towards the further dissemination of the technology of servo-mechanism is to attract to these courses sufficient technical teachers who will be able to pass on their newly acquired knowledge of servo-mechanisms and their applications to their students.

30 Million Volt Synchrotron

FOLLOWING their operation of the world's first synchrotron in 1946, the Electronics Group of the Ministry of Supply's Atomic Energy Research Establishment has now made a larger machine, producing 30 million volts X-rays. The machine has been designed at the A.E.R.E. and constructed in association with industrial firms, prominent among them being the English Electric Company, Ltd., and the General Electric Company, Ltd. The synchrotron is a new form of machine for accelerating electrons or nuclear particles to very high speeds. The present machine accelerates electrons until they are travelling so rapidly that their mass increases to sixty times its normal value. The 30 million volts which such accelerated electrons can produce would give a spark some 50 yards long in normal air. The 30 million volts synchrotron has been developed for two main purposes. First, it is acting as a model to provide information for the design of the very high energy machines now being constructed in Britain. Among these is the 300 million volts, 150-ton synchrotron being constructed by the Metropolitan-Vickers Company, Ltd., in association with the A.E.R.E. and the University of Glasgow. This later machine will be used for fundamental research in nuclear physics at the University of Glasgow, where a special building is to be erected to house it. In order to pave the way for the use of the larger machine one of the smaller 30 million volts machines has already been dispatched to Glasgow University from the A.E.R.E.

Report on Collision at Farnborough (Hants), Southern Railway

THE report on the Ministry of Transport inquiry into the collision between two up passenger trains, which took place at about 6.5 p.m. on November 26, 1947, a short distance west of Farnborough, on the main line of the Southern Railway (Western Section) from Basingstoke to London, has now been published by H.M. Stationery Office. The inquiry was in charge of Lieut.-Colonel E. Woodhouse, who also acted as assessor to the coroner for the Aldershot District at the resumed inquest. The trains concerned were the 3.5 p.m. from Bournemouth West to Waterloo and the 12.15 p.m. from Ilfracombe to Waterloo. The former train had been waiting for several minutes at an automatic signal between Fleet and Farnborough, which was at danger, through a failure of the power signalling supply, while its driver endeavoured to get into contact with the signalman at Farnborough by telephone. The following Ilfracombe train collided with it at a speed of about 20 m.p.h., severely damaging the three rear coaches. A third passenger train was fortunately stopped just clear of the wreckage. A passenger and a company's servant were killed, eleven passengers were seriously injured and eleven others suffered from shock. In his conclusion, Lieut.-Colonel Woodhouse says that the failure of the signalling power supply, and of the fuse at Sturt Lane sub-station, which caused it, though first in the series of events leading to the accident, were merely incidental to it. The accident would not have occurred if the procedure designed to meet such a contingency had been properly carried out. Nor can the automatic signalling be criticised, though most of it is forty years old. Errors on the part of the signalmen at Fleet and Farnborough are regarded as contributing to the accident.

Waterloo Station Centenary

A SMALL exhibition was opened by Sir Herbert Walker at Waterloo Station on Monday, June 14th, to mark the centenary of the opening of the station. This exhibition, which will remain open for a week, contains a number of interesting photographs, prints and models depicting the life of the station from 1848 onwards. When officially opened on June 11, 1848, the station comprised three platforms, each 300ft long. It was not until two days later that the first train entered the station—the 1.5 p.m. up mail train from Southampton. This train consisted of seven coaches hauled by the locomotive "Hornet." In those early days thirty-four trains entered and left the station each day, but within the next ten years this number had doubled. About 1860 the new North Station was opened, increasing the number of platforms to seven, and extending the station boundary northwards to the screen wall still to be seen between platforms numbered 15 and 16. This wall is about the oldest part of the terminus now standing above rail level, although older work is visible in the arches below. Other extensions were made from time to time until by 1885 there were fourteen platforms and eighteen lines of metals, over which more than 500 trains passed in and out daily. By 1911 plans were in hand for sweeping away the original station, and by the end of 1913 the original general offices had disappeared. Three months later eleven platforms were in use. The first electric service started between Waterloo and East Putney on October 25, 1915. Between the years 1919 and 1922 the final stages of rebuilding this famous station were completed and on March 21, 1922, the station in its present form was opened by Queen Mary. Since that date probably the most outstanding piece of work was carried out in the years 1935 and 1936, when the whole of the track lay-out was modernised and electrically operated points and colour light signalling were installed. According to the most recent figures, 594 trains carrying 96,565 passengers arrive every twenty-four hours, and 591 trains leave the station with 94,113 passengers.

Bermondsey Reconstructional Area

AT the meeting of the London County Council, held on Tuesday, June 15th, the Town Planning Committee recommended the Council to make application to the Minister of Town and Country Planning for a declaratory Order, making the land in the area subject to compulsory purchase for dealing with war damage. The Bermondsey area is estimated at about 170 acres. It is almost entirely dockland and riverside in character and stretches from Tower Bridge Road to Surrey Docks in the east, and the river to Jamaica Road and the Southern Railway in the south; 42 acres are occupied by roads, railways and open spaces. Nearly 20 acres consist of buildings totally destroyed or beyond repair. If buildings capable of repair are included, this figure rises to 24 acres. War damage represents 35·5 per cent of the pre-war developed area, the greater portion of which was developed before 1872. Before the war 21,700 people lived in the area. The present figure is 12,200, and the population envisaged for the reconstructed area is 12,640, or 38·5 per cent less than the pre-war figure. The area will be planned on "neighbourhood unit" principle and will comprise residential and local shopping areas and a limited amount of industry, but no special industry. Open spaces are contemplated in the zoning, and these include the ultimate completion of a riverside open space along the whole length of the river between Fountain Dock and Norway Wharf. There will be an industrial zone for commercial use. Roads of simplified lay-out will be provided, and provision is made for the duplication of the Rotherhithe Tunnel. It is expected that the Council's planning intentions can be carried out in the main within fifteen years.

A Transatlantic Train Service Comparison

By EDWARD H. LIVESAY

No. I

NO doubt there is a considerable element of truth in the aphorism "A looker-on sees most of the game," but, like many other such "wise saws and modern instances," it were best not to take this too literally. And probably better still to substitute "some" for "most"; then, if the looker-on challenges his fate by assuming the prophet's mantle, he will be on safer ground, and less likely to betray the possible superficiality of his observations by handing down dogmatic judgments. Applying this to myself, it means that in recent years I have seen a good deal of railway and locomotive work at close quarters; some, if not most, of the game; enough, it is hoped, to justify the formation of certain conclusions on some features of it. I would like to enlarge upon one or two of these, but before doing so in the following article I would draw the reader's attention to its title. This essay is intended to be a sympathetic comparison leading to a well-meant suggestion, not a carping criticism followed by a dogmatic prescription.

In 1938, while *en route* to England from British Columbia, I made most of the transcontinental journey in the cabs of representative North American locomotives, and since returning to Canada have travelled in many more. In England, thanks to the courtesy of officials of the four ante-nationalised railways, I was enabled to make a considerable number of excursions on equally representative British locomotives hauling fast trains. All this was very interesting, giving me a good insight into the work the locomotives of the two countries were doing, their design and operation, and the way traffic problems were being met and solved. A series of articles based on these experiences on both sides of the Atlantic have been given space in THE ENGINEER at different times, and before leaving England, with the Editor's approval, I fully intended summing up my observations, so far as they then went, in a concluding article of a "comparative" order; one, that is, bringing out the good and—let me say with due diffidence—the not quite so good points of the locomotives in question, and so on, in the hope that something or someone might profit, because during my peregrinations I had been struck by the surprising ignorance often shown by railway men on one side of the "Pond" of what was being done and used by their "opposite numbers" on the other. To underline this I will quote from an article dealing with "The Flying Scotsman," the first of my "British Locomotive Experiences," which is to be found in THE ENGINEER of March 31, 1939.

"Comparisons are said to be odious, but exception can often be taken to dogmatic statements such as this, and the aphorism certainly has no point when applied to these articles, which have been written largely with the idea of providing material for comparisons between North American and English locomotives and operating methods; needless to say, not to belittle one and laud the other, but to describe both, so that the reader can form conclusions of his own as to how locomotive problems met with in the two countries are being solved, and whether perhaps designers on opposite sides of the "Pond" could learn lessons from each other. I think they can; there seem to me to be devices in common use on locomotives in America, where their worth has been fully proved, that might well be tried over here. There are, conversely, features wherein English engines excel, which American engineers might do well to study. It was with these thoughts in mind that I decided to make trips on some of the principal types of engines over here, to the same end that induced me to do so in Canada and the States. . . ."

But "the best laid schemes of mice and men gang aft agley"; the war broke out, and at once our minds were occupied with enterprises of greater pitch and moment than locomotive and railway differentiations. The comparative article was never written, and so much water has gone over the dam since then that if it were attempted now on the basis of those past observations its point would be badly blunted, conditions and traffic demands having subsequently changed considerably. Furthermore, new classes of engine have been built, in Britain, some fitted with interesting devices that were not part of the make-up of those upon which I rode in pre-war days; devices which, by the way, I advocated in those articles as being worth a trial—siphons, steel fireboxes, arch tubes, mechanically operated fire-doors, window-wipers, &c. All are to be found on certain recent British locomotives. Additional runs and considerable supplementary note-taking would be advisable before venturing the said comparisons now; runs which will no doubt be duly undertaken in the near future, *Deo* and the prevailing "dollar shortage" *volente*. However, I do recall one thing in particular that struck me more than once during those locomotive experiences, undertaken in the happy non-austerity years before the world erupted; years that now seem so strangely distant and unreal; a thing that remains as evident—to me, perhaps I should qualify—to-day as it did then. I mean that an interesting and useful comparison might well be made, based on the type of train services commonly provided on North American and British railroads respectively to satisfy similar conditions, and it is around this matter that the following thesis is written. This comparison I intended making part of that projected but unwritten article; it remains pertinent, according to what one gathers from the technical and general Press as to train services in post-war Britain, and other associated matters. The heavy loads engines are now called upon to handle as a matter of course, often far greater than was the rule before the war; the continued absence of the ultra-fast trains that were introduced in the 'thirties; rumours that the drumming of the diesel-electric and the roar of the gas turbine will soon be heard in the land that the coal shortage has given us; engines more powerful than those upon which I rode before the war; all these and other facts lead me to believe that the particular comparison is still *apropos*, and so I propose to make it. Assuming it to be founded on fact, and carrying it to its logical conclusion, a type of locomotive will be outlined that would solve the problems involved.

First, let us look at typical Canadian train-services. Montreal and Toronto are two of the largest cities in Canada; each has a population approximating a million, and they lie about 330 miles apart. Passenger traffic between them is naturally considerable, though since the coming of the Motor Age a good deal has transferred itself to the fine concrete roads that serve as speedways for streams of private cars and buses hurtling along them; however, there is plenty left. At varying distances between these two great provincial centres are situated other towns of lesser but still considerable importance, from which rail and road tentacles radiate in all directions, along which in turn flows subsidiary traffic augmenting the main streams passing through these focal points—Smiths Falls, Brockville, Belleville, Kingston, Oshawa, Peterboro, and so on. A little off the beaten tracks, but closely connected with them, lies Ottawa, the capital. I do not know to what exact figure the population of all these and other smaller communities adds up, but it must be several hundred thousand. So it is evident that "through" and contributing passenger traffic between the big fellows—Montreal and Toronto—must call for considerable accommodation; if similar English conditions were to be satisfied, probably—but I will leave readers better

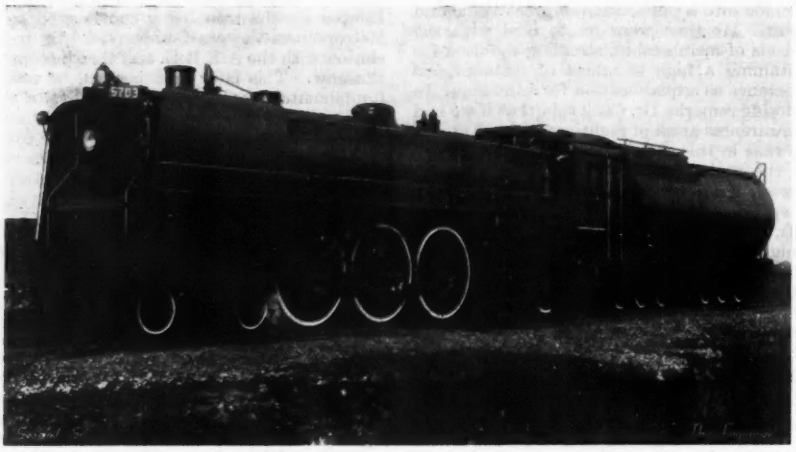


FIG. 1—CANADIAN NATIONAL RAILWAYS' "HUDSON" LOCOMOTIVE

versed than I in this matter to decide how many trains would be provided to take care of it all. Probably dozens.

The Montreal-Toronto traffic follows three routes: (1) The Canadian National main line, double-tracked throughout; (2) the Canadian Pacific, via Smiths Falls, Belleville and Oshawa, double-tracked only for the first 144 miles to Glen Tay, and (3) the Canadian Pacific, via Glen Tay and Peterboro, single-tracked from the former place, a sort of "relief" line, joining in again with No. (2) just outside Toronto. Yet over these three routes, between two great cities with a total population of over two millions, serving as they do in addition many other urban centres of considerable importance and hundreds of villages, only half a dozen trains

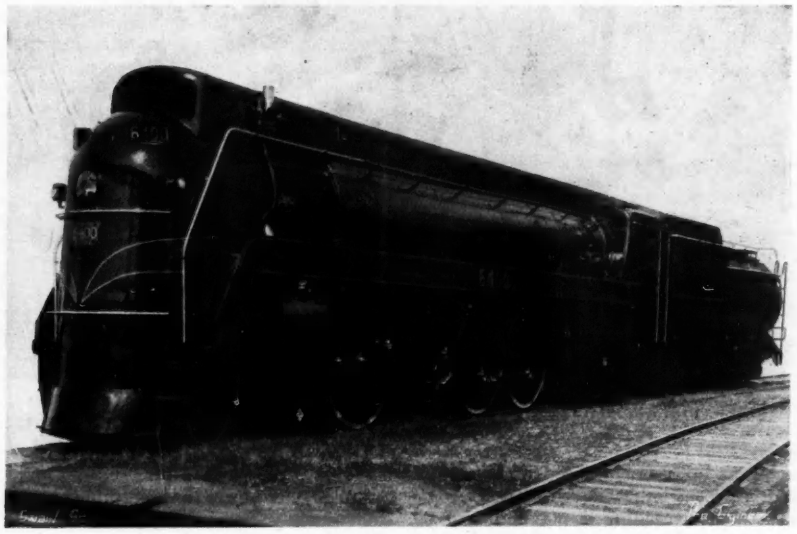


FIG. 2—CANADIAN NATIONAL RAILWAYS' "6400" CLASS LOCOMOTIVE

running in each direction are to be found in the timetables—and even one of these serves Ottawa, not Montreal.*

What is the explanation of this? It is, I think, that the Canadian railway passenger has never been pampered like his British compeer by the provision of trains running at such frequent intervals that he can find one waiting almost whenever it suits his whim and convenience to take it. He has learned to make his arrangements fit in with the timetable, not *vice versa*. If there happens to be a train when he wants one, well and good; if there isn't, "His not to question why; his but to shrug, and sigh!" Certainly he will never dream of complaining—nobody will pay the slightest attention if he does! Neither does he expect to be wafted to his destination as on the wings of the wind, reaching it at the earliest possible moment that a fast non-stop train can get him there. He raises no serious objection to frequent irruptions of passengers from way-stations into the serenity of the particular compartment (smoking) or coach that he has honoured with his presence, in which he has staked out his claim ("I guess these guys have a right to travel, too!"). He has learned from experience in an erstwhile primitive land where Jack was and still claims to be as good as his master (which is all right in theory, and flattering to his self-esteem, but doesn't mean a thing in practice) to take what is provided by whatever railway Gods there be, and be thankful. He does not assume that, as a passenger, he can rule the railway roost and act accordingly. Perhaps he understands and subconsciously acknowledges that it pays the company better to transport a ton of coal in a freight car than to provide him with a stuffed seat in an express. But I will not labour these points; in a word, he has not been spoilt by lavish train services, nor, because of not being blessed with such, does he always look for the Canadian equivalent of a corner seat. He makes the best and the most of the accommodation provided, which is seldom, if ever, in excess of his needs.

It naturally follows from this state of things and of mind that the trains serving Montreal and Toronto run at considerable intervals, are generally heavy, and not very fast—though there is one exception to this last qualification. Train weights of 1000–1500 tons are commonplace; when they exceed this figure the trains run in two or more sections. Stops are frequent, often at stations of apparently quite minor importance; stations such as an English express would spurn, and whirl through with a sniff of disdain. Average speed between terminals is seldom very high, generally in the neighbourhood of 40 m.p.h., but the maximum may reach 80; acceleration away from the numerous stops is rapid, despite the heavy loads, and up gradients speed is well maintained. The exception mentioned above is the "International Limited," a "Pool" train run jointly by the Canadian National and Canadian Pacific Railways, and with C.N. power. This is really fast, and in some ways a counterpart of certain long-distance British expresses. Notwithstanding a weight of 1000 tons or so, and hampered by eight stops, it averages 52 m.p.h. over the 334 miles from Montreal to Toronto, reaching a maximum of 80, and often holding it for considerable distances. It is one of the most outstanding expresses in Canada, and the locomotive work it entails is of the heaviest order, heavier than anything else I have noted elsewhere from the cab in North America or Britain. The booster-equipped 6ft 8in "Hudsons" (Fig. 1) are thrashed throughout the run, but do not seem to object; they are built to stand it. "The International Limited" will serve as an exemplar for the suggestion that will be made later in this essay, and around which it is written. It was described in very complimentary terms in THE ENGINEER of December 5, 1941.

So, to synthesise the above, the reader must picture passenger services in Canada as being made up of somewhat infrequent, heavy, moderately fast stopping trains in which there is little superfluous seating. Sufficient trains and passenger accommodation are provided to take care of the traffic, and no more. As for the locomotives, they are powerful, rugged machines with vitality in reserve (Figs. 2 and 3), well able to handle 1000-ton loads at 50 m.p.h. averages, which they achieve by rapid acceleration from stops and the maintenance of high speed on gradients. Lastly, long-distance, ultra-high-speed, non-stop trains are unknown. The chief dimensions of the three classes of locomotives shown in Figs. 1, 2 and 3 are given below. These engines handle much of the traffic under discussion, but the "5700" class, C.N.R., is employed exclusively on the "International Limited," for which, in fact, it was built, and for which its 6ft 8in wheels make it particularly suitable:

Now let us cross the Atlantic; what do we find in Britain? Though it is difficult to choose cities and distances that exactly parallel the Montreal-Toronto combination, if we take London as our starting point, and merge Glasgow and Edinburgh to provide a worth-while destination, we shall have a close enough analogy. Again, there will be three routes from which the passenger can make his choice: (1) the East Coast, (2) the West Coast, and (3) the central, ex-St. Pancras. The distances, in the neighbourhood of 400 miles, will be very similar, and the three lines, as in the Canadian simile, serve, in addition, many other communities *en route*. I do not know how many through trains run over these three lines between the terminal cities, but the number must be large, and if conditions even approach those that I noted before the war some of these trains will be leaving London half empty!

FIG. 3—"6400" CLASS LOCOMOTIVE

However, I imagine conditions are *not* the same; there are likely to be fewer trains, every seat will be taken, and passengers will be standing in the corridors. If this is not a true picture I am willing to sit corrected, but alas, several thousand miles separate me from the Homeland, and I am dependent upon the written word for most of my data. But

* Montreal and Toronto, Canadian cities, have been chosen to exemplify the point I am making, because they happen to do so particularly well, and because they, their train services and I are well acquainted, but almost any pair of American cities, a similar distance apart, and of similar size, would illustrate things in much the same way, so far as my observations go.—E.H.L.

before the war it did seem to me there were too many trains, often insufficiently patronised, except in the case of those of "super" persuasion, such as the "Scots" and the "Coronation," which were evidently fully appreciated, and generally pulled out loaded to the gunnels. It seemed to me then that if the travelling public had not such a galaxy of trains to choose from, but were obliged to make the most of the accommodation provided by a smaller number, economies should result, and train services would then approximate more to those found in Canada and the States. Conceivably the traveller might not have quite such a pleasant journey; he might be confined to one seat instead of permitted to drape himself over two or three, and so on, but with the conditions that unfortunately exist in Britain to-day, with shortages, including labour, rife; with rising costs, and economy the watchword; with all these and many other disabilities calling for the elimination of superfluity and wasted effort, the running of redundant trains should be added to the lengthy list of things the country can no longer afford.

Britain is now enjoying the blessings of railway nationalisation, or so it is claimed; as to this, the writer deems it advisable to preserve an open mind; in fact, a very open mind, coupling with it a sincere willingness to wait and see. But it should, at any rate, eliminate one thing—competition—and this, too, should have its effect, in leading to the cutting out of superfluous services. Here, again, a parallel can be drawn with certain Canadian happenings. Some years, ago, wasteful and financially unproductive competition between the Canadian National and Canadian Pacific Railways for the lucrative Montreal-Toronto traffic ultimately led to wisdom prevailing, and the "pooling" of the services, receipts included, so now one sees the "International Limited" made up of both companies' stock, pulling out of the Canadian Pacific's Windsor Station in Montreal with a Canadian National engine at the head, and running over both lines indiscriminately into the Union Station, Toronto. *That* should have spelt the disappearance of superfluous service, and the same thing ought to happen in Britain under nationalisation.

The result in Britain of this process of elimination—and this is what I have been leading up to—will obviously be heavier trains, and if long non-stop runs also are to become only a memory of a happier past, it may be objected that overall average speeds must necessarily come down considerably. But this is where issue is joined—or, at any rate, the assumption will be queried in this essay. It is reasonable enough if only engines of existing types and power are pictured handling the fast, heavy stopping trains that, it is assumed, will be the rule in the future. In that case, double-heading would, of course, be inevitable, but this is ruled out of consideration; neither factor—existing locomotives nor two of them—is contemplated.

I believe an engine could be built, and run over existing British lines that would be capable of taking a 600-ton train single-handed from London to Edinburgh or Glasgow at an average speed of 60 m.p.h., making at least half a dozen stops *en route*, and without exceeding a maximum of 90. It need be neither freakish nor unduly complicated; violate no present standards and follow accepted practice; be in no way experimental, nor call for alterations to stations, track and bridges, and would fit in with present equipment well enough. Impossible—fanciful—Utopian? Not a bit of it! I am convinced it could be done. Moreover, I am not suggesting an engine with, say, a mere 10 per cent or so power increase over existing patterns; an increase as a rule only available for short periods at the expense of Herculean labour by a harried, perspiring fireman attempting the impossible with a mocking shovel. I have seen this kind of thing on the footplate more than once, and to any man of goodwill it is agonising to watch. Similar crimes against humanity were committed at Dachau and Buchenwald! No engine of *that* pattern is suggested; it would be quite inadequate. I visualise one 50 per cent more powerful than anything running in Britain at this time; for instance, half again as powerful as the L.M.S. "Princess Coronations," of which I have always been an ardent admirer. Even an engine modelled on the lines of the Canadian types seen in Figs. 1, 2 and 3, which handle the fast and heavy trains running between Montreal and Toronto would be impracticable. British axle-load restrictions rule out "Hudsons," though booster assisted. A booster is only of value at starting; I am postulating an engine with great tractive power available at any time, and all the time, and with ample boiler power to back it up continuously not merely for brief periods. A 4–8–4? No, that would not do either; wheel-loading limitations would make impossible the 60,000 lb T.E. that this projected engine should have, because the factor of adhesion would be too low. The length of a 4–8–4, increased by the necessary large-capacity eight-wheeled tender, would call for bigger turntables, and easier curvature in the neighbourhood of King's Cross,† if at no other points in the three routes to the north, and finally, its overhang would probably scrape a foot or two off York platforms and make the negotiation of Preston interesting! Yet, though we are aiming high, our target can be reached and hit. Even if none of the "standard" types would serve, I am convinced a steam locomotive could be built on familiar lines to do the work foreseen; one equal in power to the twin diesel-electric machines that are planned to haul the East

FIG. 4—CANADIAN PACIFIC RAILWAYS' "3100" CLASS LOCOMOTIVE

	C.N.R. "5700" class	C.N.R. "6400" class	C.P.R. "3100" class
Type	4–6–4	4–8–4	4–8–4
Cylinders	23in × 28in	24in × 30in	25½in × 30in
Valve gear	Baker	Baker	Walschaerts
Driving wheels	6ft 8in	6ft 5in	6ft 3in
Boiler: Diameter	78in – 86in	78in – 86in	—
Length	19ft 1in	21ft	20ft 5in
Pressure	275 lb	275 lb	275 lb
Heating surface	3,377 sq. ft.	5,391 sq. ft.	6,998 sq. ft.
Grate area	73·6 sq. ft.	73·6 sq. ft.	93·5 sq. ft.
Tractive effort: Main Cylinders	43,300 lb	52,457 lb	60,800 lb
Booster	10,000 lb	Can be fitted	Not fitted
Factor of adhesion	4·36	4·49	4·08
Weight: Engine	158 tons	170 tons	189 tons
Tender	137 tons	127 tons	138 tons
Total	295 tons	297 tons	327 tons
Coal	20 tons	20 tons	21 tons
Water	14,000 galls.	11,700 galls.	12,000 galls.

† I remember, during a visit to England in 1934, going to King's Cross time and again, seeking acquaintance with the "Cock o' the North," 2–8–2 class, at long last to have my perseverance rewarded and my withers wrung on finding "Earl Marischal" off the metals near the end of the departure platform, leaning wearily over at a sad angle, blocking several sidings and switches. I hate to think of a 4–8–4 attempting to negotiate the same tracks! I often wondered why the late Sir Nigel Gresley, who designed the "Cock o' the North" class, did not give lateral play to the front coupled axle, and the thought came to me more than once during my trips on "Mons Meg" over the sinuous Edinburgh-Dundee line (THE ENGINEER, October 6, 1939), though in the resulting article I glossed over the question, and carefully avoided saying what I certainly thought at the time—that the type was not suitable for that particular route, or in fact for the negotiation of anything approaching serious curvature. There are hundreds of eight-coupled—and even ten-coupled—engines in Canada and the States, running without difficulty over much more severe curvature than is found in Britain, but they are all fitted with lateral motion devices to one or more axles as a matter of course. Had such an arrangement been applied to the "Cock o' the Norths," perhaps it would not have been necessary to convert them to "Pacifics," as has been done recently. While regretting this necessity, I cannot say I was surprised thereat.—E.H.L.

Coast expresses in the future (which together will have a T.E. of over 60,000 lb, so evidently the estimate of power required from the projected engine is not excessive); one which should cost less to build and maintain than these multi-cylindered oil-electric combinations, however effective they may prove in action, and which could burn coal, our unlimited home-produced fuel—provided the miners will condescend to dig it!

(To be continued)

Ruhr Coalfield Statistics

By Sir R. A. S. REDMAYNE, K.C.B.

SINCE the publication of the Technical Report on the Ruhr Coalfield by a mission from the Mechanical Advisory Committee of the Ministry of Fuel and Power, dated February 13, 1946, which was reviewed in THE ENGINEER of June 21st of the same year, there have appeared from time to time a number of appendices to the main report (which constituted Volume I), namely, Volume II, in two parts, comprising diagrams and illustrations, and Volume III, embodying no less than thirty appendices. The last of these appendices,* issued recently, is described as "Production Statistics for Mines in Flat, Medium and Steep Formations," although these particulars are hardly "statistics" in the ordinary acceptation of the word, being, largely in the nature of tabulated technical particulars relating to methods of working plant and machinery operative at five specified mines out of the 137 mines from which the Ruhr coalfield is at present being worked. We are not informed why these particular mines have been selected, but it may, perhaps, be inferred as being mines representative of the various parts of the field. They are:

(1) The Hannover mine, in the Bochum-Hordel locality.

(2) The Hannibal mine, in the same district.

(3) The Jacobi mine, in the Rhineland.

(4) The Königsborn I/II mine, at Heeren-Werwe, Unna, Kreis and

(5) The Shafts I and II of the Nieder-Rheinisch Mining Company, Ltd., locality not stated.

In some of these mines the inclination of the seams must be considerable, for the division of conveying in the month of May, 1944 (or last but one normal month), according to formation groups, was in respect of (1) 60 per cent of tonnage from flat formations, 13 per cent from medium formations, and 27 per cent from steep formations. In case (2) 73 per cent from flat, 4 per cent from medium, and 23 per cent from steep formations. In case (3) 100 per cent from flat formations, in case (4) only 11·26 per cent from the flat formations, but 88·76 per cent from steep formations; and in the last case 100 per cent from flat formations.

For "flat" formations the inclination is taken as being 0 deg. to 25 deg., in "medium" the range is from 25 deg. to 35 deg., and for "steep" 35 deg. to 90 deg. It will be seen, therefore, that a considerable variation exists in regard to natural conditions existing in the five instances given in the report. In Great Britain we have very few mines working coal seams of an inclination of from 25 deg. upwards, so, for purposes of comparison with a modern British mine, from the point of view of similarity of natural conditions, instance (3)—the Jacobi mine—would be the best one to take. The seams at this mine are fairly thick, varying from 43in to 75in, and fairly free from interstratified bands of stone as shown by the thickness, exclusive of stone, namely 37in to 63in of coal and the inclination was only 0–5 deg. The Jacobi mine has a daily production reaching to (October, 1939) 5909 tons, and an output per man-shift of 43·3 cwt (2·16 tons), the counterpart to which will be found in a number of modern collieries in South Yorkshire, Nottinghamshire and Derbyshire. For though, for the whole of Great Britain, the output per man-shift was in 1939 only 1·14 tons, in some of our modern collieries working under favourable natural conditions the average exceeds 2 tons. The comparative averages, according to the Reid report of March, 1945, were for 1938, in respect of the Ruhr, 1·523 tons, and Great Britain 1·148 tons. But the seams in the Ruhr show a greater average thickness than in the case of Great Britain.

A useful table is given in each case which shows the shifts worked at various classes of work per 100 metric tons conveyed, but it would have been of much more value, for the institution of comparison, both internally and internationally, had it been extended so as to give the proportion of shifts devoted to the actual getting of the coal to the total shifts worked at the colliery in all classes of work.

It is in this respect, owing to the superiority of the natural conditions existing in regard to the coal mines of the United States, that the coal industry of that country is enabled to show so much better output per person than any other country. There 60 per cent of the manpower at the mines is employed at the coal face in the actual getting of the coal as against 20 per cent in the case of Great Britain, so that the average output per man-shift (bituminous coal plus anthracite) is more than two and a half times the British figure, being, for the period 1933–1942, 2·9 tons as against 1·0 ton in respect of Great Britain. In the main report (page 5, Vol. I), it is stated that in 1936 an output of slightly more than 2 tons per man-shift was obtained in the Ruhr mines, after which there was a gradual decline, efforts being made to arrest the decline by developing and applying power loaders. But if we turn to the report of the Technical Advisory Committee to the Ministry of Fuel and Power (dated March, 1945) we find the comparative figures to have been as follows:

	Tons per man-shift	
Year	Ruhr	Great Britain
1913	0·930	1·016
1925	0·931	0·901
1936	1·683	1·177
1937	1·600	1·168
1938	1·523	1·148

In the main report (Vol. I) it is stated that "pneumatic picks are used almost universally for coal getting in the Ruhr mines." Their success depending largely on the friability of the coal—as a matter of fact, taking the Ruhr collieries as a whole about 85 per cent of the coal is so obtained. Sometimes they are used (though seldom) together with explosives.

In only three instances, in the cases covered by the appendix, are other methods used; in the President seam of the Hannibal mine on one coal face, at a face in a seam in the Jacobi mine, and at a face in the mine of the Neider Rheinisch Company other machines are used. The use of pneumatic picks is extending somewhat in our own coal mines, but it must be borne in mind in this connection that the coal obtained under such conditions is of smaller size than that obtainable by the application of undercutting coal machines, an important point where coal is supplied for household purposes; where the coal is naturally of a friable nature (e.g., as in the instance of much of the Kentish coal) and will not stand up to undercutting, the case is, of course, different.

The mode of loading the coal at the face into tubs is, in the great majority of instances, by various forms of conveyors; apparently mining practice in the Ruhr, as in Great Britain, is behind that of the United States in respect of the application of face mechanical loaders.

The means of filling the space left by the excavation of the coal ("waste" or "goaf") with shale, rock or sand in many cases is by the hydraulic method of stowing, so long in use at the German and French collieries, but in some instances the more recent pneumatic method is employed; at others hand filling is still practised. The latter is, for reasons of practicability and economy—owing to the prevailing conditions—still in almost universal application at British coal mines.

Where we have most to learn from German mining practice seems to lie in underground haulage. The tendency in the Ruhr is to concentrate the haulage of the coal on one main mechanical haulage road—where the measures are highly inclined the "lay-out" of the mine allows of this—and of the use thereon of locomotives, either of the trolley wire or the fuel oil type, and on the in-by or subsidiary haulage roads, of the battery or the fuel oil kind.

To permit of the adoption of locomotives of either type in many of our mines would necessitate some alteration in our safety rules, a matter which requires most careful consideration before being embarked upon. I well remember, whilst making an underground inspection of a colliery in the Ruhr, some years ago, witnessing the electric flashes on the main haulage road where the trolley wire system was in operation, and on inquiring of the manager whether there had ever been an explosion at the mine, being informed that one had occurred a year previous to my visit—from what cause I do not remember; but from whatever cause, it would seem to be asking for trouble to employ at a colliery which had experienced an explosion a system of underground haulage which produced electric flashes!

Which leads one to the consideration of the subject of mine ventilation. In four out of the five collieries under consideration particulars are given as to the type of ventilator in use, with revolutions per minute, volume of air current, and height of water gauge. The volume of air in some instances is very considerable; thus at the Hannover mine, with a Westfalia Dinnendahl double-inlet fan, a current of as much as 423,776 cubic feet per minute is circulated, the speed of the fan being 127 r.p.m., and the height of the water gauge 14½in. At the same mine, another fan of the same type, running at 300 r.p.m., is circulating 141,259 cubic feet per minute at a water gauge of 11 $\frac{15}{16}$in. These mines must be either very extensive or there

* Technical Report on the Ruhr Coalfield, Vol. III, Appendix No. 30. London, H.M. Stationery Office, 1948, price 1s. 6d.

must be other considerable impediments to the flow of air, for in their main report (Vol. I) the investigating committee say: "It is not unusual to find water gauges as high as 18in due to the ventilation in the main shafts, underground level drifts and Staple shafts." Such excessive heights of water gauges are unknown at British collieries, where the height seldom exceeds 4in.

Winding of coal, in the instances given in the appendix before us, is carried on from considerable depths, varying from 1181ft to 3199ft. Shaft diameters are from 11ft 11$\frac{11}{16}$in. to 21ft. 4in. Both as to depth and diameter of shaft conditions comparable to those obtaining at the deeper of the British coal mines.

The drainage of the mines in the cases before us is chiefly performed by centrifugal pumps, electrically driven. At the Hannover mine 278,986 cubic feet (about 174,662 gallons) of water are raised in twenty-four hours against a head of 2559ft. The advantage in using centrifugal, as opposed to reciprocating pumps, for mine drainage is, of course, compactness, in saving space, in simplicity of foundations and in high efficiency, though, in the latter respect, that of three-throw pumps is higher under conditions of high head and low quantity of water. The tendency in British mines is towards the greater use of centrifugal pumps under conditions of high head and large quantities of water.

Sparse attention is devoted in the Committee's main report to the subject of the cleaning of the coal, though we do learn that only at one plant is coal more than 3$\frac{1}{2}$in in size subjected to washing. In the Reid report, however,† it was stated: "In some Continental mines, despite the use of pneumatic picks, the whole of the mine product, with the exception of the largest lumps, which are hand picked, is washed." But we are not informed what percentage of the whole output from the Ruhr coalfield is subjected to washing. In the year 1939, 47 per cent of the British output was subjected to mechanical cleaning. It is regrettable that in this respect the particulars are so meagre, especially in view of the fact that coal mining to-day is so largely carried out by mechanical cutting, so that the product contains more dirt than under hand-hewing conditions, and that the matter of dealing with it is of increased importance, and will become more so in the future, with the development of power loading at the face and the working of inferior seams.

In the appendix no reference is made to costs, possibly because of no information in respect thereof being available to the committee.

In conclusion, the committee is to be congratulated on having carried out an excellent job of work and in having made a valuable contribution to our knowledge of German mining practice.

The Turn-Round of Shipping

THE Working Party on the Turn-Round of Shipping in the United Kingdom Ports, which was appointed by the Minister of Transport in September last, has now presented its report (H.M. Stationery Office, price 9d.). Mr. W. G. Weston, of the Ministry of Transport, acted as chairman of the Working Party, the membership of which included representatives of both sides of the port transport industry, the General Council of British Shipping, and the Dock and Harbour Authorities' Association.

For the purpose of its investigations, the Working Party formed small teams, mostly from its membership, which visited all the major ports of the United Kingdom and which assisted the port authorities and organisations concerned to consider suggestions and recommendations put forward. One section of the report deals with the equipment of the ports and in what follows we quote the Working Party's observations on that subject.

Equipment of the Ports

"We found that loading and discharging of ships and the handling of cargo through the ports could be greatly speeded up if shortages of mechanical equipment were overcome and suitable operations were more completely mechanised. The reports from our teams indicate that most ports are short of modern quay cranes. In many cases authorities are awaiting new cranes from manufacturers, which are not likely to be delivered for eighteen months or two years. Even in those ports where the authorities have no cranes on order, the condition and type of existing cranes in many cases are such that re-equipment will soon be necessary. The provision of adequate cranage facilities is essential and we consider further action is needed to help the individual ports. It may well be in the national interest for more cranes to be allocated for port use in the United Kingdom at the expense of exports. We therefore recommend that a programme of crane requirements covering all ports should be prepared by the Ministry of Transport, in consultation with the British Transport Commission and the Dock and Harbour Authorities' Association, with an indication of the urgency of the various requirements. This will give a measure of the home demand over the next few years for comparison with export requirements and will facilitate decisions on the allocation of materials for crane production.

"We are satisfied that in the majority of the United Kingdom ports many operations in the docks are now performed by hand which could be partly or wholly mechanised. We are equally satisfied that this would result in quicker turn-round of shipping and would relieve the men of heavy and monotonous labour. In reaching this conclusion we have not overlooked the many examples of successful mechanisation in our ports, not only for bulk commodities such as grain and ores and specialised cargoes such as bananas, but also for general cargoes. We were impressed, however, by the wide disparity in the degree of mechanisation of similar operations between one port and another and even between different employers in the same port. We found that port authorities and other employers, and the trade unions were agreed that in principle increased mechanisation was desirable. In practice, however, its development is hindered by the unwillingness of some employers to invest capital in plant, on which they believe for various reasons they will not obtain a reasonable return, and by the long-standing prejudice of some of the men against any innovation which, if it is to be effective, must reduce the number of men required to perform a given operation.

"A prerequisite to increased mechanisation is, therefore, to establish confidence among port authorities and other employers that machines purchased will be efficiently and economically used and among the men that such machines will genuinely improve their conditions of work. Finally, both sides must be equally confident that any scheme for mechanisation will increase the efficiency of the port. We consider that in the ports where difficulties arise greater use should be made of the conciliation machinery of the National Joint Council to resolve problems arising out of increased mechanisation. Ship and quay working consists of a series of operations and the limiting factor in the rate of work of the whole ship is the speed of the slowest operation. It is, for instance, quite useless to increase crane facilities to discharge cargo beyond the rate at which slings can be made up in the holds or at which cargo can be cleared on the quay or in the lighters. It will be apparent, therefore, that schemes for mechanisation require close study by experts and we do not propose to make any detailed recommendations in this report. We recommend, however, that a comprehensive review be made by a small expert team of the possibilities of increased mechanisation in the ports. We think this review should include a study of practices in foreign ports. The team should include representatives of working dockers, master porters and stevedores, shipowners and port authorities.

"It may prove beyond the financial powers of individual master porterage and stevedoring firms to provide all the plant required for full efficiency. This difficulty must not be allowed to interfere with the progress of mechanisation and, if it arises, port authorities should consider forming pools of equipment. This has already been tried successfully in some cases. Port authorities are having difficulty in obtaining the mechanical equipment they require, as for many types they have to compete with other industrial undertakings. We think that the manufacturers should be advised of the importance of the ports' needs and of their estimated requirements for the future. We therefore recommend that the Ministry of Transport should collect the details of outstanding requirements and discuss with the Ministry of Supply means of making adequate supplies available.

"The difficulty of obtaining spare parts and materials for maintenance of plant is having serious results in the ports. Our teams were informed of instances of diesel trucks and other appliances being immobilised for lack of one or two relatively small items. It has recently been decided that the priority symbol for cast iron and steel may be quoted on urgent orders for port equipment and civil engineering requirements connected with port works. This should help port authorities to obtain such items as steel rollings, steel plates and reinforcement bars and we recommend that the Ministry of Transport should use this symbol wherever possible to overcome serious shortages. Its use, however, does not extend to manufactured standard components. We have consulted the Ministry of Supply about these components and have been advised that it is impracticable to determine a detailed pattern of distribution to customers. Nevertheless, it is our view that the needs of the ports are important and urgent. We recommend that the Ministries of Supply and Transport should bring the importance of the port requirements to the notice of the manufacturers. We also consider that these departments should be prepared to assist individual port authorities in obtaining delivery of spares where their lack is seriously affecting port operations."

General Observations

Some general observations made in the report emphasise the necessity that, at all times, the port industry should work with the maximum efficiency, and it is pointed out that in current circumstances it is a matter of vital national concern that ships should be loaded and discharged expeditiously. One way of helping to make good the losses inflicted in our merchant shipping during the war is to improve the performance of the ships we possess. In that way, the report says, resolute working in our own ports can help to overcome the serious effects upon our national economy of the shortage of ships.

† The Technical Advisory Committee appointed by the Ministry of Fuel and Power to examine the present technique of coal production from coal face to wagon and advise which technical changes are necessary to bring the industry to a state of full technical efficiency, which reported in March, 1945.

Exhibition of Inventions.—The second annual exhibition organised by the Birmingham branch of the Society of Inventors is to be held at the Chamber of Commerce Building, Birmingham, from October 25th to 30th next. The object of the exhibition is to display new devices produced during the year. Non-members as well as members are permitted to submit entries, which must be either patented, protected or of registered design. Particulars of the exhibition may be obtained from Mr. B. Thornton Clark, 244, Stoney Lane, Yardley, Birmingham, 25.

British Welding Research Association

WE were recently invited by the British Welding Research Association to pay a visit to its new research station at Abington Hall, near Cambridge. It will be recalled that in 1945 the Association purchased an estate, Abington Hall, near Cambridge, in order that it might be developed as an engineering research centre, complementary to the metallurgical laboratories which are established at the headquarters of the Association at 29, Park Crescent, London, W.1. Considerable progress has been made in equipping the station, and research work has now been well established in many directions. Last month, on May 11th, over fifty members of the Association, and organisations connected with it, held the first meeting at Abington Hall, when the work done in transforming the country mansion into a research station was seen and several problems connected with future research were discussed.

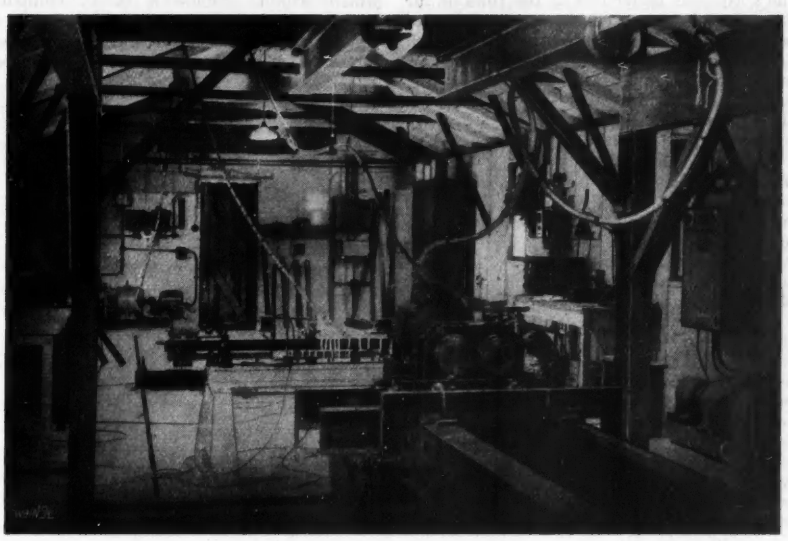
The party was welcomed by Sir William J. Larke, the President; Sir Stanley V. Goodall, the Chairman; and Dr. H. G. Taylor, the Director of Research, and Dr. F. A. Fox, the Deputy Director. The work now in progress at Abington Hall is divided into four principal sections. That on frame structures is in the hands of Dr. T. W. Roderick, while the fatigue strength of welded sections is being dealt with by Dr. R. Weck. Light alloy spot welding is in charge of Mr. T. M. Roberts, and the testing of welded and seamless pipes and pressure vessels is entrusted to Mr. N. Gross. Part of this work is being carried out, for convenience, in the engineering laboratories of Cambridge University.

The Hall, a view of which is reproduced herewith, has been adapted in the upper storeys to meet the living needs of the staff, and on the ground floor there is a large council room, a smaller committee room, general offices and a drawing-office. In the basement there is room for further laboratory accommodation and storage rooms. The main research work is being carried out on an outside testing site in special buildings, and in the stabling, which has been cleverly converted into laboratories and workshops. Power is obtained from the local electricity supply and some 270kW is needed for the station.

ABINGTON HALL

Structural Frame Tests

Considerable interest was shown in Dr. Roderick's outside testing station, which has been designed for the testing of frame structures. The problems now being solved will have an important bearing on the future development of structural engineering. It is clearly recognised that one of the great advantages of welding, as applied to structures, is the comparative ease with which rigid structures can be formed. Unfortunately, the full use of this new method has been retarded by existing building regulations. According to the "British Standard for the Use of Steel in Buildings," the connections are assumed to be pinned, the beams are designed simply as supported members and the stanchions as pin-headed columns loaded at some arbitrary eccentricity. The only rational method, it is claimed, of designing steel frames is that which is set out in the "Final Report of the Steel Structure Research Committee." That method, however, only deals with the elastic behaviour of structures and takes no account of the ability of a rigidly connected frame to carry load after some yielding has taken place. Unlike pin-jointed frames, welded frames, it was found, did not become unserviceable at the first signs of yielding, but went on to carry considerably more load. In order, therefore, to obtain the full economy from welding it becomes necessary to take account of the plastic range of deformation in defining the working condition for a rigid frame structure. Ten years ago, on the completion of the work of the Steel Structure Research Committee, Professor Baker, with the support of the Welding Research Council, undertook a programme of research on the ultimate strength of rigidly connected steel structures. Since that time a good deal of work has been done to determine the extent to which the collapse load of such structures exceeds the load producing the first signs of yield. It has been possible to build up a theory which takes into account both the elastic and the plastic properties of steel, and so far as this theory has been developed it has enabled the collapse load of simple structures to be determined with satisfactory accuracy. In the past the main experiments were made with stanchions, and the study of continuous stanchions is being continued. With the object, however, of making the results of such work immediately available to engineers, meetings were held in Cambridge with designers and members of the British Constructional Steel Association, and it has been possible to work out a simple design method for structures of the portal frame type.



FATIGUE TESTING LABORATORY

In applying this new method of design it was arranged that the emphasis should be shifted from the aspect of conventional stress and the structure designed to fail under a factored load. By such means it becomes possible to achieve a worthwhile saving in weight, which varies in different cases from 15 to 27 per cent, as compared with the old conventional designs. A full report on this work has been prepared and circulated, and it is being followed up by comprehensive series of tests on miniature portal frames.

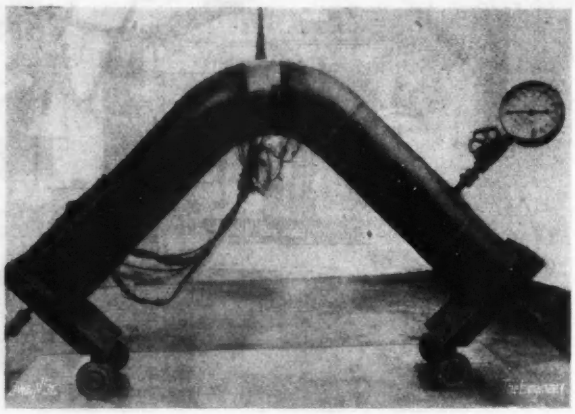
It has been possible, however, in spite of difficulties in obtaining materials, to set up the testing rig, which has been specially arranged to load a pair of portal frames having a span of about 16ft and a height of about 8ft. The load is applied by adding weighed sections of tractor track, which can be used for 75 per cent of the load. Another 25 per cent can be added by running water into a pair of pressed steel tanks, each holding 2½ tons of water, which are suspended from the frame. By means of pulley arrangements a side load is also applied to simulate wind stress. In all cases arrangements are made to measure and record deflections, and the stresses imposed are calculated from readings taken from a complete Maihak electric strain gauge installation. It is expected that the mild

steel test frame will collapse at a load between 5 and 6 tons.

Fatigue Strength of Welded Sections

The testing of the fatigue strength of welded structures is carried out in a special building which has been constructed in the grounds, and we show a view of the apparatus, which is adapted to test the best method of joining angle stiffeners to ships' plating and to investigate the influence of internal stress upon the fatigue strength of materials and structures.

The specimens under test at the time of our visit to the laboratory consisted of sections of ships' bulkhead or deck structures, to which angle stiffeners had been attached by various forms of welding. It is desired to find the method of welding attachment which gives the highest fatigue strength, and for this particular test five different types of joint have been chosen and four specimens made of each. The testing machine makes use of the resonance method, which enables comparatively high stresses to be induced in large specimens using low powers. In the test referred to the test piece is 8ft in length by 2ft in width and is composed of $\frac{1}{2}$in plates stiffened with two 5in by 3in by $\frac{3}{8}$in angles. By supporting the test piece at the node positions and applying out-of-balance weights driven by a small electric motor, it has been possible to obtain fibre stresses of over 14 tons per square inch during continuous running over long periods. Constant strain can be maintained by controlling the amplitude of vibration, a point near resonance being chosen. Fractured specimens were seen and others were being X-rayed by the Admiralty in order to determine the exact condition of the welded joints. Several testing machines of this type have been constructed, including a push-pull type of machine, using a similar method of stress excitation. In investigating internal stress and its influence on fatigue strength, the method of applying stress, both tensile and compressive, by means of induction heating has been chosen, after which the bars are tested by the resonance method of fatigue test. The extent of surface stress can be determined by measuring the change in distance between a network of gauge points on the bars, before and after induction heating, and again after the bars have been subdivided.



Fabricated Pipe Test Piece

Light Alloy Spot Welding

This section of the laboratory has been installed in the stabling and, so far, two Philips condenser type spot welding machines have been installed with the necessary electrical equipment. In addition, we noted slitting saws and grinders for the preparation of light alloy specimens from the sheet. A 3-ton Avery tensile testing machine is also available. Work in this section is now well in hand, and a number of tests have already been carried out.

Alongside the welding machine laboratory is the main workshop, in which has been installed an electrically driven lathe, a drilling machine, a power saw, and shaping, milling and grinding machines. The drill, shaping machine and saw are conveniently arranged between two doors so that the longest members can be machined.

Pipe and Pressure Vessel Testing

The equipment at Abington Hall for testing the strength of welded pipes and pressure vessels has been considerably improved during the past year. Use has now been obtained of a high-pressure, 10,000lb, Fielding and Platt hydraulic test pump, driven through a Heenan and Froude electric slip coupling by an electric motor, an arrangement which provides a 0 to 95 per cent speed regulation. By this means any desired range of hydraulic pressures can be obtained. Work at present includes a number of tests for comparing the behaviour of welded and seamless pipe bends. In modern power station work pressures of 700 atmospheres and over are used with high temperatures, and further investigation of pipe bends was required. During the war it was found necessary to replace seamless imported pipe bends by welded pipe bends made in this country. The B.W.R.A. recently undertook to carry out experiments which would provide a direct comparison between welded and seamless pipe bends subjected to internal pressure and to such external forces as would be produced by changes in temperature. These experiments have been carried out under Professor J. F. Baker at Cambridge University engineering laboratory and at Abington Hall. We show a typical view of a test specimen consisting of a 90 deg. bend of 6in pipe such as is used for a pipe line. The pipe bends are stress analysed by means of a brittle lacquer and by electric resistance strain gauges, applied to the inside and outside of the pipe bend. The changes in diameter and the deflections of the bend under increasing pressure are also recorded. The internal pressure tests were carried to destruction, while in other tests external loading was applied until collapse took place. From the experimental results obtained it is seen that when a pipe bend is under the influence of external forces, tending to decrease its radius of curvature, the dominant stress is a transverse stress located in what was in the past thought to be the neutral axis. Theory and practice show that the largest stresses occur at these points on the inside surface of the pipe bend. Under the action of external forces alone with static loading conditions, the pressed welded bend in a nonheat-treated state was found to be equal in strength to the seamless bend. Experiments also revealed that the load-carrying capacity of such bends, whether welded or seamless, was not exhausted when the stress in part of the structure reached the yield point, but that about twice the load that was needed to produce the first permanent set could be carried without producing unduly large deflections. Indeed, as in other mild steel structures, the ratio of the load causing failure to the working load was greater than normally expected. Further experiments have been carried out on bends under the action of fluctuating pressures, under repeated application of external loads and under the influence of sudden increases of pressure.

Work is also planned on the investigation of stress conditions in and around typical connections to pressure vessels. For these experiments a full-scale pressure vessel is being built by John Thompson, Ltd., of Wolverhampton, and will be shortly available for laboratory experiments. It will be 10ft in length and 3ft 6in internal diameter, with a wall thickness of $1\frac{3}{4}$in. Three branches of 12in internal diameter, with different wall thicknesess of $\frac{1}{2}$in to $1\frac{1}{4}$in will be provided.

The Birthday Honours

In the King's Birthday Honours List, which was published on Thursday, June 10th, the following names appear:—The Order of Knight Bachelor is conferred upon Mr. Robert Crichton, chairman of the West Cumberland Industrial Development Company, Ltd.; Mr. Arthur Gouge, vice-chairman and chief executive of Saunders-Roe, Ltd.; Mr. Geoffrey Heyworth, chairman of Lever Brothers and Unilever, Ltd.; Mr. Cyril Norman Hinshelwood, Professor of Chemistry, Oxford; Mr. Ellis Hunter, deputy-chairman and managing director, Dorman Long and Co., Ltd., Middlesbrough, and president of the British Iron and Steel Federation; Mr. Godfrey Way Mitchell, chairman of George Wimpey, Ltd., and Mr. Harold Ernest Georges West, managing director of the Newton Chambers Companies. In the Order of the Bath (Military Division) General Sir John Tredinnick Crocker, late R.T.C., becomes G.C.B., as also does Air Chief Marshal Sir John Cotesworth Slessor, R.A.F. The K.C.B. is conferred upon Vice-Admiral (E.) Ford, Engineer-in-Chief of the Fleet, and Air Marshals the Hon. Sir Ralph Alexander Cochrane, R.A.F., and Sir Leslie Norman Hollinghurst, R.A.F. The C.B. (Military Division) is bestowed upon Rear-Admiral (E.) the Hon. D. C. Maxwell, Brigadier H. Bainbridge, late Corps of R.E., Major-General W. H. Stratton, late Corps of R.E., and Group Captain G. I. L. Saye, R.A.F. The C.B. is also conferred upon Mr. H. M. Garner, principal director, Scientific Research (Air), the Ministry of Supply, and Mr. O. Thornycroft, Director of Aeronautical and Engineering Research at the Admiralty. In the Foreign Office List, in the Order of St. Michael and St. George, Mr. N. W. Allen, until recently Director of Irrigation, the Sudan Government, becomes C.M.G. A similar award is conferred upon Mr. J. O. Sanders, the general manager of the Malayan Railway.

In the Order of the British Empire (Military Division) the K.B.E. is bestowed upon Air Vice-Marshal Alan Filmer Rook, R.A.F., and Acting Air-Commodore Frank Whittle, R.A.F., Sir Hector James Wright Hetherington, Principal and Vice-Chancellor of the University of Glasgow, becomes K.B.E. in the Civil Division. In the Military Division, Engineer-Captain W. T. A. Jordan, R.N. (rtd.) and Brigadier C. G. Stewart, R.E.M.E., become C.B.E.s. In the Civil Division the C.B.E. is conferred upon Mr. S. G. Taylor, Director of Irrigation, Ceylon; Mr. J. R. Farquharson, general manager of the Tanganyika Railways; Mr. J. W. Norris, chief inspecting engineer, the Crown Agents for the Colonies; Colonel R. W. Butler, divisional road engineer, Eastern Division, the Ministry of Transport; Mr. H. W. Cremer, President of the Institution of Chemical Engineers; Mr. E. S. Curphey, Deputy Director of Dockyards, the Admiralty; Mr. S. Davey, Director of Contracts (Air), Ministry of Supply; Mr. G. R. Dawbarn, partner, Norman and Dawbarn, Architects and Consulting Engineers; Professor A. Finlay, for services to chemistry; Lt.-Col. W. French, superintendent, Technological Department, City and Guilds Institute, London; Mr. A. A. Griffiths, research engineer, Rolls-Royce, Ltd.; Mr. G. S. Hallas, Director of Works, Air Ministry; Mr. W. F. Higgins, superintendent, Physics Division, National Physical Laboratory; Mr. C. Hollyoak, chief superintendent, Royal Ordnance Factories, Woolwich; Mr. H. J. Humphries, lately divisional inspector of mines, Ministry of Fuel; Mr. P. Croom-Johnson, chief engineer, London Transport Executive; Professor W. R. Jones, Professor Emeritus, University of London, and Imperial College of Science; Mr. C. Kershaw, director of British Optical and Precision Engineers, Ltd.; Mr. A. King, chief scientific liaison officer, Office of Lord President of the Council; Mr. G. F. O'dell, Director of Contracts, General Post Office (Kingston-on-Thames); Lt.-Col. J. A. A. Pickard, Director-General, the Royal Society for the Prevention of Accidents; Mr. H. B. Robin Rowell, chairman of R. and W. Hawthorn Leslie and Co., Ltd., Newcastle-on-Tyne, and Mr. Norman Wilkinson, marine painter.

Some Recent Advances in Mechanical Engineering on Shipboard*

By T. A. CROWE, M.Sc., M.I.Mech.E.†

DURING the twenty-five years which have elapsed since the last summer meeting was held in Glasgow, considerable advances have been made in mechanical engineering on board ship. This applies not only to the main propelling machinery, but also to the numerous auxiliaries required both in connection with the main engines and for the extensive hotel services provided in a modern liner.

It is not possible within the scope of one paper to deal with the advances which have been made in all the different types of machinery. Attention will therefore be confined to the development of geared-turbine machinery for typical North Atlantic liners. The ships which have been selected are the "Franconia," "Duchess of Bedford," "Empress of Britain," "Queen Mary," "Queen Elizabeth," and "Caronia." The leading dimensions of the ships and particulars of their machinery are shown in Table I

TABLE I.—*Particulars of Vessels Selected to Illustrate the Development of Geared Turbine Machinery*

Owners	Cunard Steamship Company, Ltd.	Canadian Pacific Steamships, Ltd.		Cunard White Star Company, Ltd.		
Year entering service	1923	1928	1931	1936	1940	1948
Ship's name	"Franconia"	"Duchess of Bedford"	"Empress of Britain"	"Queen Mary"	"Queen Elizabeth"	"Caronia"
Number of screws	2	2	4	4	4	2
Length of ship, overall	624ft	600ft	760ft 6in	1,019ft 6in	1,031ft	715ft
Gross tonnage	20,160	20,120	42,350	81,235	83,673	34,000
Total s.h.p. on service	12,500	18,000	60,000	158,000	158,000	35,000
Speed in knots	16·0	17·5	24	29	29·5	22
Speed of propellers, r.p.m.	90	115	Inner 150 / Outer 200	180	180	140
Boilers:						
Number	3 double-ended and 3 single-ended	Main 6 / Auxiliary 2 single-ended	Main 9 / Auxiliary 2 single-ended	Main 24 / Auxiliary 3 double-ended	12	6
Type	Cylindrical	Yarrow / Cylindrical	8 Yarrow, 1 Johnson / Cylindrical	Yarrow / Cylindrical	Yarrow	Yarrow
Steam pressure	220	350 / 200	425 / 200	400 / 250	425	600
Steam temperature	Saturated	686 / Saturated	725 / Saturated	700 / 620	750	800
Draught (open or closed stokehold)	Open	Open / Open	Open / Open	Closed / Open	Closed	Open
Turbines:						
Type	All impulse	Impulse reaction	Impulse reaction	Impulse reaction	Impulse reaction	Impulse reaction
Number per set of machinery	3	3	3	4	4	3
Speed of turbines, r.p.m.	H.P. & I.P. 2,750 / L.P. 1,770	H.P. & I.P. 1,910 / L.P. 1,525	H.P. & I.P. & L.P. Inner 1,365 / Outer 1,795	H.P. I.P. 1,533 / I.P. L.P. 1,035	H.P. I.P. 1,533 / I.P. L.P. 1,035	H.P. 3,686 / I.P. & L.P. 1,990
Condenser:						
Type	Non-regenerative	Regenerative	Regenerative	Regenerative	Regenerative	Regenerative
Vacuum, inches of mercury	28·25	29	29	29	29	29
Feed system	Closed	Open	Closed	Closed	Closed	Closed
Feed water temperature, entering boiler, deg. Fah.	200	300	320	330	330	345
Fuel consumption (propulsion only), lb per s.h.p.-hr.	0·696	0·57*	0·543*	0·56	0·553	0·538
Electric generators:						
Type	Turbo	Turbo / Diesel	Turbo / Diesel	Turbo	Turbo	Turbo
Number	2	2 / 2	2 / 4	7	4	4
Total output, kW	750	1,000 / 900	1,600 / 1,800	9,100	8,800	4,400
Total weight of machinery, including water, tons	2,400	2,309	6,551	13,785	12,016	3,175
Total weight per s.h.p., lb	430	287	244	195	170	204

All consumptions have been corrected to a common calorific value of 19,000 B.Th.U. per pound. * Diesel generators in use.

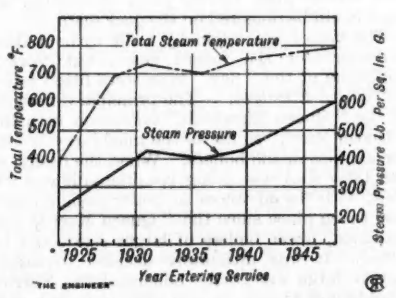


FIG. 1—*Increase in Steam Pressure and Temperature*

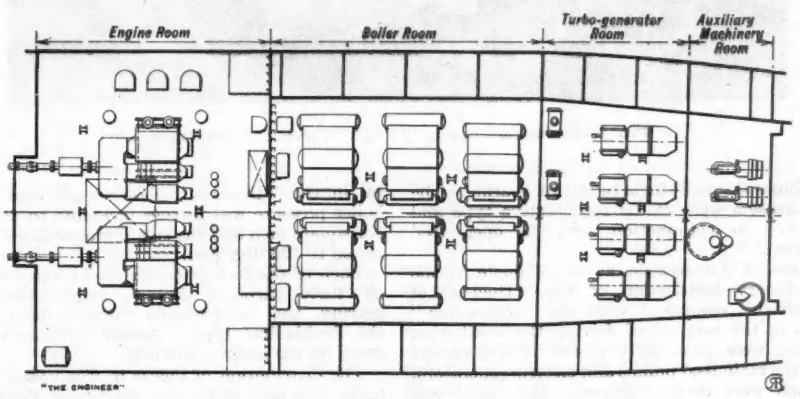


FIG. 2—*Arrangement of Machinery of T.S.S. "Caronia"*

For boilers of this type, and marked the high-water mark of the art of boiler making. Each double-ended boiler had a capacity of 32,520 lb of steam per hour and weighed 189 tons, including the weight of water at working level. The weight of steam produced per hour per pound weight of boiler was therefore 0·077 lb.

At about this period very considerable trouble was experienced with double-reduction gearing, bringing it into disfavour for many years, but it is satisfactory to note that the "Franconia's" gearing has not given trouble.

The condenser were fitted with Admiralty-steam and Scotch boilers, to high-pressure, high-temperature steam and water-tube boilers. One of the primary factors which enabled this change over to be made was the introduction at about this period of the cupro-nickel condenser tube. The "Duchess" class of vessels were amongst the first to be fitted with these tubes, which almost eliminated the risk of salt water getting into the boilers with all its attendant troubles.

The "Duchess of Bedford's" water-tube boilers worked at a pressure of 350 lb per square inch and a steam temperature of 686 deg. Fah.

MAIN PROPULSION MACHINERY

"*Franconia.*"—The machinery of this vessel, which was designed in the period immediately following the 1914–18 war, although not completed until 1923, consisted of double-reduction geared turbines supplied with steam from Scotch boilers. The vessel was fitted with twin screws and each shaft was driven by three turbines. The boiler pressure was 220 lb per square inch, which was approaching the limit for boilers of this type, and marked the high-water mark of the art of boiler making. Each double-ended boiler had a capacity of 32,520 lb of steam per hour and weighed 189 tons, including the weight of water at working level. The weight of steam produced per hour per pound weight of boiler was therefore 0·077 lb.

"*Duchess of Bedford.*"—The construction of this vessel, completed in 1928, marked the change over from low-pressure, low-temperature steam and Scotch boilers, to high-pressure, high-temperature steam and water-tube boilers. One of the primary factors which enabled this change over to be made was the introduction at about this period of the cupro-nickel condenser tube. The "Duchess" class of vessels were amongst the first to be fitted with these tubes, which almost eliminated the risk of salt water getting into the boilers with all its attendant troubles.

The "Duchess of Bedford's" water-tube boilers worked at a pressure of 350 lb per square inch and a steam temperature of 686 deg. Fah.

* Glasgow summer meeting, Institution of Mechanical Engineers, June 15, 1948.

† Engineering director, John Brown and Co., Ltd., Clydebank.

The boilers are of the single-flow type without any means of controlling the superheat temperature. Each boiler had a capacity of 27,260 lb of steam per hour, and weighed, including water at working level, 86·4 tons. The weight of steam produced was therefore 0·142 lb per pound weight of boiler, or about twice the weight of the steam produced by the Scotch boilers fitted in the "Franconia." The boiler drums were of the solid forged type with riveted-in ends.

The "Duchess of Bedford" was fitted with twin screws, and each shaft was driven by three turbines through single-reduction gearing. The condensers were of the regenerative type and worked in conjunction with an open feed system.

One of the greatest advances made in the machinery installation of the "Duchess of Bedford" compared with the "Franconia" was in the method of driving the auxiliaries. These were principally motor driven, except for the main feed pumps and electric generators, which were turbine driven. The vessel was also fitted with two diesel generators. The fitting of electric instead of steam auxiliaries did much to bring about the reduction in fuel consumption for propulsion purposes from 0·696 lb per shaft horsepower-hour in the "Franconia" to 0·57 lb per shaft horsepower-hour in the "Duchess of Bedford." The saving of fuel was also greatly assisted by the fitting of large four-flow air heaters to the water-tube boilers; this reduced the funnel temperature to 345 deg. Fah. and increased the boiler efficiency to 85 per cent.

Two Scotch boilers were fitted for supplying steam for hotel services and for the turbine glands. This ensured that no contaminated drains were returned to the main water-tube boiler feed system, and also that nothing but distilled make-up feed was added to the main feed system. All make-up feed first passed through the Scotch boilers.

"*Empress of Britain.*"—The machinery installation of this vessel was on the same lines as that which had proved so successful in the "Duchess" class vessels, but the boiler pressure was further increased to 425 lb per square inch and the steam temperature was raised to 725 deg. Fah.

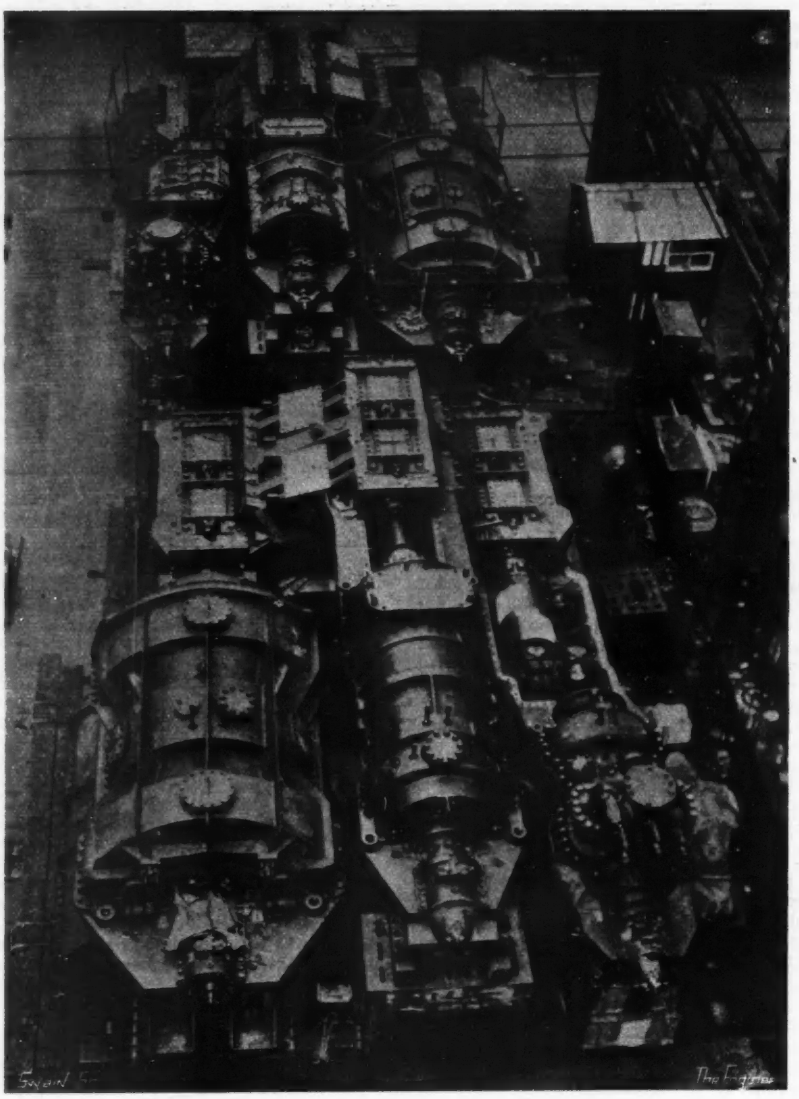


FIG. 3—*Turbines and Gearing of T.S.S. "Caronia" in Erecting Shop*

Each of the four propeller shafts was driven by three turbines through single-reduction gearing, the low-pressure turbines being of the double-flow type. Astern turbines were fitted on the inner shafts only.

The distribution of power in this vessel was unusual, as each of the inner shafts was of double the power of the outer shafts. This subdivision was arranged to meet "cruising" conditions when a reduced speed was required. Under these conditions the after engine-room which drove the outer shafts could be completely shut down, and the propellers removed, thus enabling the forward engines to operate nearer to full power, and therefore more economically.

The fuel consumption of this vessel was 0·543 lb per shaft horsepower-hour for propulsion purposes, which corresponds to a thermal efficiency of 24·7 per cent based on a calorific value of 19,000 B.Th.U. per pound. The boiler efficiency was further increased to 88 per cent with a funnel temperature of 226 deg. Fah.

The boiler plant consisted of eight Yarrow boilers and one Johnson boiler for propulsion purposes, and two Scotch boilers for hotel services and gland steam. Both the Yarrow and Johnson boilers were of the double-flow type with superheaters fitted on one side only, so that the superheat temperature could be controlled by a damper in the uptake. The drums of the Yarrow boilers were of the solid forged type with closed-in ends. The drums of the Johnson boiler were solid forged with riveted-in ends.

Unlike the "Duchess of Bedford" the "Empress of Britain" was fitted with a closed feed system.

"*Queen Mary.*"—The total power in this installation is equally divided over four shafts in two engine-rooms. Each shaft is driven by quadruple-expansion turbines—high-pressure, first intermediate, second intermediate, and low-pressure—through single-reduction gearing.

The power of the "Queen Mary" was dictated by the speed necessary to maintain a weekly service between Southampton and New York at all seasons of the year, including the necessary time to turn the vessel round at each terminal port.

In installations such as this, reliability and simplicity, coupled with quietness in running, are factors of primary importance.

In the determination of steam pressure and temperature conditions for the "Queen Mary" reliability was given precedence over all questions of economy, as any economy which might be gained with increased pressures and temperatures would be easily discounted if any delay occurred in such an important passenger and mail service.

Therefore the steam conditions on the "Queen Mary" were fixed at 400 lb per square inch and 700 deg. Fah. Steam for the main engines and propulsion generators is supplied by twenty-four water-tube boilers. Steam for the hotel generators and other hotel services is supplied by three double-ended cylindrical boilers at a pressure of 250 lb per square inch and 620 deg. Fah.

In the "Queen Mary" the oil fuel consumption for propulsion purposes only is about 0·56 lb per shaft horsepower-hour, the hotel consumption being about 48 tons per day. The fuel consumption for all purposes is about 0·586 lb per shaft horsepower-hour. The designed service power of this vessel is 158,000 s.h.p.

When the "Queen Mary" was built the power to be transmitted by her gearing considerably exceeded that of any other merchant vessel afloat. Each main gear wheel weighed 75 tons. It required three months' continuous work day and night for seven days a week to cut the teeth in each gear wheel.

It is interesting to note that when the gearing was examined at the conclusion of her war service after eleven years' operation, no wear could be detected on the gear teeth.

The vessel was originally built without dust collectors for the funnel gases, but Vortex collectors of the "dry" type were fitted later.

"*Queen Elizabeth.*"—The principal difference in the "Queen Elizabeth" compared with the "Queen Mary," so far as the machinery is concerned, lies in the boilers. When the design of the later ship was being considered it was felt that, with the advances in boiler design which had taken place since the "Queen Mary" was designed, fewer boilers of larger size could be fitted. It was ultimately decided to install twelve large water-tube boilers of the Yarrow double-flow type to do the work of the twenty-four water-tube boilers and three Scotch boilers in the "Queen Mary." This reduction in number of boilers enabled the number of funnels and funnel hatches to be reduced from three to two, with considerable advantage to the lay-out of the public rooms and other accommodation.

The steam conditions were also slightly increased to 425 lb per square inch and 750 deg. Fah.

The elimination of the Scotch boilers had

other effects also. The separate hotel service generators were eliminated, and four turbo-generators of larger capacity were installed to deal with both main propulsion and hotel load.

In the "Queen Elizabeth" the large independent air intakes for the forced draught fans were eliminated; the air was taken in through slats at the base of the funnels, and down through the funnel hatches to the fan rooms. This alteration saved cutting through the passenger accommodation with the air trunks, and the large volume of cool air passing down the funnel hatches prevented the accommodation in this vicinity from becoming overheated.

Although the dry type dust collectors fitted in the "Queen Mary" had proved very satisfactory, it was felt that wet type collectors would be still more efficient, and consequently these were installed in the later vessel.

The "Queen Elizabeth" was completed in February, 1940, shortly after the outbreak of war, and it was decided that she should be sent across to New York.

Although it is generally known that the ship left the Clyde without undergoing the usual sea trials, some further information on this point may prove of interest. The decision to send this valuable vessel across the Atlantic in wartime without trials was not arrived at without the most careful consideration, and special precautions were taken to test the various parts of the machinery installation as thoroughly as possible while the vessel was in the basin at Clydebank. The usual dock trial was, of course, carried out, but as it is impossible to moor a ship of this size sufficiently securely to enable the engines to be run at anything except "dead slow," it was not thought that this trial was adequate. Each propeller shaft was therefore uncoupled from the line shafting and all the turbines, gearing, thrust blocks and intermediate shafts were run continuously for two hours at the revolutions corresponding to full power. Thus all the journal bearings in the turbines were tested under full load and speed conditions, and the gear case journal bearings were tested under full-speed, light-load conditions.

Each boiler of this ship being of approximately double the size of those fitted in the "Queen Mary," it was desired if possible to carry out a boiler trial before sending the vessel across the Atlantic.

In order to test one boiler under full-power conditions, all turbo-generators were run up to approximately full output and the electrical load generated was absorbed partly by resistances, and partly by running all the large auxiliaries such as forced draught fans, main circulating pumps, ship's ventilating fans, &c., up to maximum output.

The other novel feature which it was desired to test was the air supply to the boiler-room fans. This was accomplished by steaming a forward boiler taking its air down the forward funnel hatch as required for combustion, and running all the forced draught fans in the two after boiler-rooms up to the capacity of air calculated to be required for full-power steaming. Under these conditions it was found the drop in air pressure from the atmosphere on deck, through the air intake slats and down the funnel hatch to the fan rooms was only about ¼in water gauge.

TABLE II.—*Voyage Speeds of "Queen Elizabeth" from the Clyde to New York*

Date	Distance run, miles	Average speed, knots
March 2, 1940	58	19·55
March 3, 1940	627	24·11
March 4, 1940	629	25·16
March 5, 1940	616	24·64
March 6, 1940	680	27·20
March 7, 1940	508	22·66

The vessel proceeded down the Clyde on February 26, 1940, and after four days at the Tail of the Bank to take in oil and fresh water, &c., she sailed for New York on March 2, 1940.

A naval escort was provided as far as the North of Ireland in case any unforeseen machinery troubles arose which might have caused the "Queen Elizabeth" to slow down or stop at sea—a contingency which is always liable to arise the first time a vessel goes to sea. Fortunately nothing did arise and the vessel made a non-stop voyage to New York. The average daily speeds are given in Table II:

"*Caronia.*"—The machinery of this vessel, which will shortly be completed, was designed in the period immediately following the 1939–45 war, and marks another advance in mechanical engineering on board ship. The steam pressure in this vessel has been increased to 600 lb per square inch, and the temperature to 800 deg. Fah. The increase in steam pressures and temperatures on the vessels under review is shown in Fig. 1.

The arrangement of the main machinery in this vessel is shown in Fig. 2, and Fig. 3 shows the turbines and gearing in the erecting shop.

The vessel is driven by two shafts and each shaft is driven by three turbines.

With the advances which have been made in gear cutting since the early 1920s, the troubles which were then experienced with double-reduction have been overcome, and the high-pressure turbines of the "Caronia" drive the propeller shafts through double-reduction gearing. The intermediate and low-pressure turbines drive through single-reduction gearing. The reduced size of high-pressure turbine which can be fitted at the increased rate of revolutions possible with double-reduction gearing is of great advantage at the higher steam pressures and temperatures adopted in the "Caronia."

The gear teeth of the high-pressure primary pinion and gear wheel are of the "all-addendum" type, i.e., the pinion teeth are all addendum and the wheel teeth are all dedendum. In the period under review, the design and construction of marine gears have changed very little—a remarkable tribute to the foresight of the late Sir Charles Parsons. The involute tooth, sometimes with varying proportions of addendum and dedendum, still holds the highest position in marine transmission. This tooth form has the great advantage that it allows for the change of centre distance due to differential thermal expansion of the gears and gear cases, while still maintaining correct meshing of the gears—an advantage not possessed by certain other tooth forms.

The greatest development of all in the gearing field has been the improvement in the accuracy of gears, in tooth form, in circumferential pitch, in helical angle and in tooth finish.

The low-pressure turbine casings and gear cases of the earlier vessels referred to above are all of cast iron, but in the case of the "Caronia" these parts are of fabricated construction. The bearing housings are made of cast steel and the remainder is built up of welded steel plates. By adopting this method of construction a considerable saving in weight is effected. One of the low-pressure turbine gear cases is shown in Fig. 4. Each bottom half gear case weighs 34 tons.

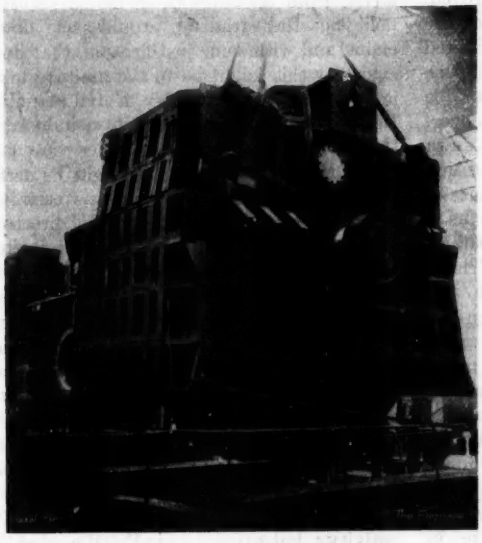


FIG. 4—*Main Gear Case of T.S.S. "Caronia"*

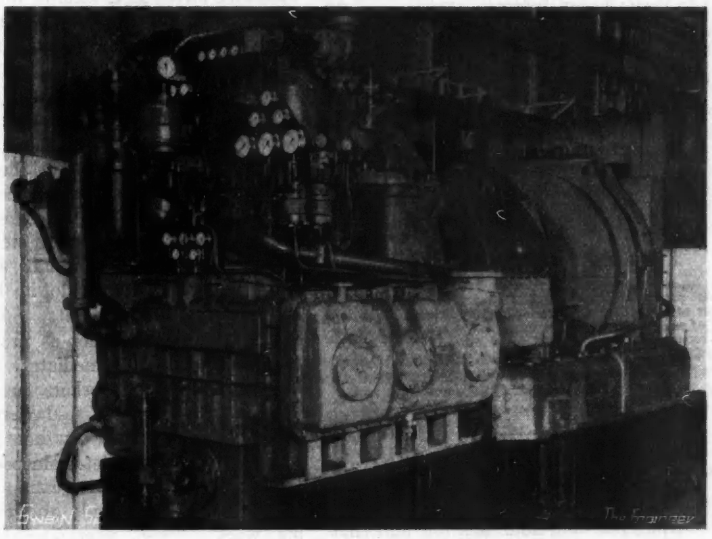


FIG. 5—*Pass-Out Turbo-Generator of T.S.S. "Caronia"*

Steam is supplied for main and auxiliary purposes by six water-tube boilers of the Yarrow double-flow type, similar to those fitted in the "Queen Mary" and "Queen Elizabeth," except that the boiler drums are of all-welded construction. The superheater drums are made from solid-drawn tubes with closed-in ends.

A departure has been made from the tubular air heaters fitted in the earlier vessels by installing rotary regenerative heaters of the Howden-Ljungstrom type.

The supply of low-pressure steam for heating purposes is obtained by bleeding the turbo-generators, and not by fitting desuperheaters and reducing valves as in the "Queen Elizabeth."

The notes which conclude the paper refer generally to the auxiliaries of the "Queen Elizabeth," although reference is made in a few cases to auxiliaries for other vessels. The turbo-generators of the "Caronia" are of special interest, because they are the first pass-out turbo-generators to be fitted on board a British ship. These generators take boiler steam at 600 lb per square inch, and 800 deg. Fah., and steam is bled from the turbines at 60 lb per square inch for thermotank heating, calorifiers, galleys, &c. One of the Allen turbo-generators is shown in Fig. 5.

THE ENGINEER

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NOTICE TO READERS

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PRODUCTION PER MAN HOUR

Two years ago there were complaints by managements up and down this country that output per man-hour was low and that workers in industry were not pulling their weight as they should. Undoubtedly, there were grounds for such complaints, even though there were a number of reasons why low productivity could temporarily be expected. Plants were being turned over from war to peace production, there was in many works a very high turnover of personnel, amounting to 60, 70 and even 80 per cent of those employed, demobilised men returned from the forces still needed time to settle down and to pick up again their old skill and their old rapidity, materials were in short supply and delivery, particularly of fuel, was unreliable. All these and many other factors tended to disorganise production, to unsettle workpeople, and to give additional colour to complaints of low productivity. But to-day a spirit that we regard as healthier rules. It is critical as much of managements as of men if outputs are low. For though there are and always will be some among the workers who are ineradicably suspicious of every managerial proposal or command; and though too often it is just such people who are chosen by the men to represent them as shop stewards and union executives; and though some amongst the men will for ever strive to get as much as possible for themselves, while giving as little as they dare to the firm, it is, we believe, nevertheless, true that if there is a bad atmosphere in the shops, critical, unco-operative and unproductive, it is as likely to be the fault of management as of the men. Improved production per man-hour, in fact, is now being sought less through exhortations to harder work than through managerial methods that create the desire to work.

With changes in production methods there has been created a need for changed managerial methods. It used to be thought that methods of payment by results whereby the wage packet became heavier the greater the amount produced was all that was needed to keep production high. There is to-day no doubt of the value of such systems. But their limitations in laying the incentive to hard work wholly on each worker's self-interest and not at all on team work has become more apparent. Often such incentives have in themselves proved bones of contention between managements and men, more particularly when productive methods have been altered and improved. Their very object has been flouted when the more expert workers have voluntarily limited their outputs for fear that rates might be lowered or their less effective fellows be penalised or thrown out of work. Moreover, as operations are more and more broken down so that increasingly semi-skilled repetition work replaces skilled work, the weaknesses of personal incentives by themselves as a spur to effort are becoming more apparent. In the past the craftsman worked hard because he took a pride in his job and enjoyed the doing of it. Such men—so few seem left—were not as prone to watch the clock and be immediately ready to go home as modern workers are. But the "machine minder" of to-day, repeating the same operations hour by hour, assembling repeatedly the same detail, inspecting minute by minute the same parts, cannot be expected to show the same pride and enjoyment in his work. Nor, particularly perhaps in these days of shortages when there is little in the shops that he can buy, can the normal monetary incentives alone press his output beyond a certain point. Something more is needed to give him enthusiasm for his work.

It is that something that managements are struggling to evolve. A number of firms are making experiments in managerial methods. Psychologists have been called in to study workers' reactions and to advise upon the placing of new entrants into suitable jobs. There is much talk and discussion. For it is recognised that if standards of living in this country are to be maintained, let alone raised, output per man-hour must go up. Yet, as Mr. Dyson shows in a paper which we publish in abstract in this issue, much of what needs to be done amounts to little more than the application of common sense. He points out, for instance, that out of all the employees of a factory only some 40 to 60 per cent are actually on the production floor. There is clearly scope for the improvement of methods of work by the remainder. He points out how effective mere good leadership can be in "enthusing" teams of people with the attitude of mind not only willing but desiring to give of their best, and he discusses simply what these things are that create "the motive of personal enthusiasm." It is, we believe, a healthy development that managements should now encourage workers to take an interest and a pride in the well-being of a factory as a whole, its efficiency and its rate of output, in short, to work together as a team. But in attempting to achieve that end let us be wary of the application of too much semi-scientific psychology. It aways has been and always will be one of the jobs of management to endeavour to create a desire to work. Many of the actions needed to bring that end about can be discovered by the application of a little common sense combined with observations upon the results of practical experience.

OPERATIONAL RESEARCH

A STRIKING growth of the last war was the novel activity known as Operational Research. It was something new that those responsible for the direction of war should take counsel, at the highest level, of scientific advice from civilian sources on questions of policy. Industrialists would no doubt claim, and with some justification, that however new this might be to the military mind it would show little novelty in civil planning. But if this were true for certain industries, there were many where the older view prevailed that although science might be useful in its right place, that place was certainly not at the sacred board table of the directors. Nor in the between-war years had science found any seat reserved for it in the Councils of the Defence Services. It would perhaps have been too much to expect that the Army would take the lead in any such innovation, nor, as it happened, did the Admiralty seek thus to crown its pioneer work as the first Defence Department to create within its organisation a directorate of scientific research. It was in the most youthful of the three Services that initiative was taken, and in the very newest of its new forms of warlike activity; but even the Air Force needed the stimulus of the approach of war to induce it to take so bold a step. In earlier days, the Air Council, though it might, and did, profit by many of the latest scientific discoveries, did not—so far as we are aware—invite the civilian scientific expert to share in its own discussions. He was outside the council room, available to answer as well as he could any questions remitted to him, but when those answers were under discussion, and operational decisions of high policy were being reached, he was not there.

Under war pressure a better plan arose. The story is admirably told in the officially published booklet "Science at War." The drive came from the obvious bearing on operations of the discoveries and improvements made in radar at the Telecommunications Research Establishment (T.R.E.), first located at Bawdsey, then at Dundee, then near Swanage, and finally at Malvern (changes in location considered necessary by strategical considerations). The first step was the loan of a few T.R.E. scientists to the headquarters of R.A.F. Fighter Command at Stanmore, and, as the official story tells, this group made itself so useful that by the time the period of loan had elapsed, the Commander-in-Chief asked that the arrangement should continue. By the summer of 1941 operational research had so proved itself

as to become recognised by the Air Ministry as an important activity, and the decision was taken to set up Operational Research Sections widely in the R.A.F. With the Army it was natural that operational research should begin with anti-aircraft gunnery, which though an Army Command was under the operational control of the R.A.F. Fighter Command; Professor Blackett was appointed to take charge of this work. A year later he went to the Admiralty to act as their first Director of Naval Operational Research. Thus all three Services came to take their part in this new development, and the scientific staffs concerned grew in size and importance. Corresponding action was taken in the civilian defence department under the Ministry of Home Security, and this included investigations into the physiological and medical effects of bombing.

Applications of the many aspects of operational research grew rapidly and covered studies of naval and air mining, anti-submarine policy, the optimum size of convoys, the efficiency of bombing and mining attacks on coastal shipping, the efficiency of aircraft maintenance, the causes of losses of bombers, the risk of aircraft collision during raids, the relative part played by enemy fighters, accidents, fire and anti-aircraft gunnery in causing bomber losses, the accuracy of shooting from tanks, and the best priority test for the bombing of enemy targets. There were many other matters studied also; indeed, operational research came to survey then, as now, the whole of the three fields of weapons, of tactics, and of strategy. This pioneer work was initiated in Britain, and no small share in the credit for it must go to Vice-Chancellor Rowe, of Adelaide University, who throughout the war was head of T.R.E., and was assisted by a very able staff. The German High Command did nothing whatever on these lines. Hitler did not like either the scientists themselves or their attitude to life—especially the Nazi life; so they were little used (outside the Luftwaffe), and even when employed were commonly put under the direction of men who were better qualified as party members than as scientists. In Britain we were wiser; long before the critical year 1939 our own leading scientists had been provisionally apportioned (without their knowledge, of course) between the scientific divisions of the Service Departments, and when war came appropriate action was taken and most willing help was given. Their opposite numbers in Germany were called up for ordinary military duty and only partially released when it was far too late—no small factor in the final issue of the war.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

I.MECH.E. INCREASE IN SUBSCRIPTIONS

SIR,—I have been able to follow the correspondence in your columns regarding the above, and have also read your two leaders.

I plead guilty not only to voting against the increase, but also inciting other members to do the same by means of a letter to the technical press setting forth my reasons.

I am sorry that in your leader you do not envisage a voter opposing the increase because he felt members were entitled to more information regarding the rise in expenses which made it necessary.

If I had had any qualms as to my action, which I definitely did not possess, I should have had my mind set at rest when I found that the voting papers dated March 18th were in existence at the time of the annual general meeting held on March 19th. I understand that no reference to the proposed rise in subscription rates was made at this meeting.

You have referred to different motives which cause persons to value membership of the Mechanicals. The value of membership largely depends on prestige attaching to the Institution, and the prestige of the Institution will ultimately depend on whether the Council and staff of the Institution, to paraphrase the statement so often made by our Judges in regard to justice, "See to it that not only are the highest traditions of procedure observed, but also *appear to be observed*."

It is necessary in these days when too many people think less of how ends are gained than that they shall be gained, that the procedure of an Institution of the importance of the Mechanicals shall be correct to the point of pedantry.

KYRLE W. WILLANS

Ilminster, Somerset, June 14th.

EXPORT OF MACHINE TOOLS

SIR,—Sir Peter F. Bennett, in an address to members of the Machine Tool Trade Association, is reported to have said:

"In exporting these capital goods (machine tools) in such large numbers to the detriment of home industries, we are giving overseas producers the primary means of competing with our exports of consumer goods in the future."

Sir Peter makes this statement in order to support his case against the present policy of exporting machine tools to the disadvantage of home users. Surely his case is strong enough anyhow and does not need to be supported by an outworn argument. Machine tools and, for that matter, all those capital goods used in production processes, are directly responsible for raising the standard of living in whatever communities they may be employed, and with the standard of living they raise the purchasing power of individuals in those communities. One is therefore driven to contradict Sir Peter in his statement. Though, for example, Indians may begin to use British machines to make consumer goods which had hitherto to be imported from the U.K., such activity will undoubtedly add to their purchasing power. If the purchasing power of the average Indian, which is now less than £30 per year, were raised by not more than £1 per year through the employment of surplus labour in industry, there would be another £450 million chasing goods. Surely even the most highly organised Indian industrial activity will hardly be able to cope with all that increased purchasing power.

London, S.W.10, June 14th. C. F. BROOK

THE BRITISH IRON AND STEEL RESEARCH ASSOCIATION

SIR,—In your report of Mr. R. B. Templeton's Presidential Address to the Institute of British Foundrymen for this year (issue of June 11th, page 577) you perpetuated what must have been a slip of the tongue by referring to the "Iron and Steel Industrial Research Council" as being "busily engaged on research."

The Iron and Steel Industrial Research Council ceased to exist on December 31, 1944, its activities in co-operative research being then taken over by the British Iron and Steel Research Association. It is indeed accurate to credit this latter body with being "busily engaged" as your readers will have observed from your various reports on its activities. In fact, co-operative research in the iron and steel industry has increased by well over five times since B.I.S.R.A. was established.

M. E. DAVIES,

Public Relations Officer, B.I.S.R.A.

London, June 11th.

International Conference on the Safety of Life at Sea

THE fifth final plenary session of the International Conference on Safety of Life at Sea took place on Thursday evening, June 10th, at the Institution of Civil Engineers. In his speech, Sir John Anderson, the President, outlined briefly the main results that had been achieved by the combined labours of the delegates at the conclusion of seven weeks of strenuous work. In the construction of passenger ships the conference had made an important advance by the introduction of new regulations for minimising the danger of outbreak of fire. Standards of watertight subdivision for passenger ships had been strengthened by including new requirements concerning the stability of ships in a damaged condition. Cargo ships had been included in the regulations of the New Convention for the first time in relation to such matters as navigation, radiotelegraphy, lifeboats and life-saving and fire-extinguishing appliances. A new International Certificate for cargo ships had been instituted. The conference had recommended the application of Convention principles to all cargo ships and fishing vessels as far as reasonable and practicable. All aspects of life-saving appliances had been reviewed. In all passenger ships and in all cargo ships over 1600 gross tons it is provided that a continuous watch is to be kept, either through human agency or by human agency assisted by an automatic listening device. Ships between 500 and 1600 gross tons will generally be required to carry radiotelephone apparatus. The safety of navigation and the collision regulations were closely examined. The Convention will come into operation on January 1, 1951, provided the necessary number of acceptances have been received by that date. Sir John closed his remarks with thanks to all who had ministered to the needs of the delegates and to Admiral Farley, the Head of the American Delegation, for so readily accepting the position of Vice-President. The Minister of Transport, Mr. Alfred Barnes, said that the conclusions of the conference represented a major advance in the campaign for greater safety of life at sea. He announced that His Majesty's Government would be happy to undertake the duty laid upon it by the new Convention, of acting as the Bureau Power until such time as the duties of the Bureau Power might be taken over by the International Maritime Consultative Organisation.

BOOKS RECEIVED

Vector and Tensor Analysis. By Louis Brand. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 33s.

The Inventor and his World. By H. Stafford Hatfield. Middlesex: Penguin Books, West Drayton, Middlesex.

Rubber to Metal Bonding. By S. Buchan. London: Crosby Lockwood and Son, Ltd., 39, Thurloe Street, S.W.7. Price 21s.

Technical Optics. Vol. I. By L. C. Martin. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, W.C.2. Price 40s.

Quality Control in Production. By H. Rissik. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, W.C.2. Price 21s.

"*Electrical Engineer*" *Reference Book.* Third edition. London: George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2. Price 42s.

A Text Book of Electronics. By J. M. A. Lenihan. London: English Universities Press, Ltd., Saint Paul's House, Warwick Square, E.C.4. Price 12s. 6d.

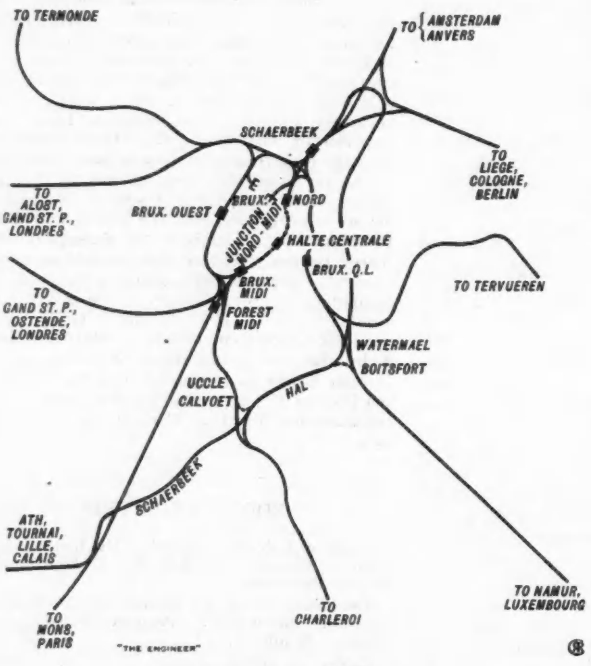
The Brussels North-South Rail Connections

By the late C. F. B. LEMAIRE*

THE city of Brussels and its suburbs fall within a roughly rectangular area, 7½ miles long and 5½ miles broad, served by an extensive railway network. There are no fewer than a dozen terminal stations, and a great marshalling yard at Schaerbeek. Of the passenger terminals the two most important are Brussels North (Bruxelles-Nord) and Brussels South (Bruxelles-Midi).

A look at the map, reproduced herewith, shows that the existing Brussels railway network provides for traffic by various routes through and around the city. But the Nord and Midi stations are about 2 miles apart, and at present the only rail connections between them is by means of a loop to the west, or a longer and as yet incomplete loop to the east, which requires a linking line C for its operation. A direct connection between the stations, as indicated on the map, obviously would be of great advantage. Linking the northern and southern railway networks, it would give much improved facilities and would eliminate lengthy and costly train movements by making the Nord and Midi "through" stations.

Such a scheme was started before the war. It is now well advanced, and forms the subject of this article. The scheme will also permit the building of a central station (Halte Centrale) between the Nord and Midi stations in the heart of the business and Government offices area.



BRUSSELS RAILWAY NETWORK

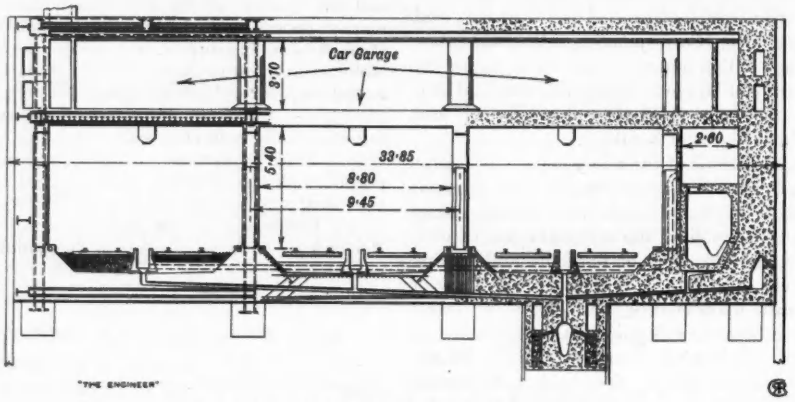
Another aspect of the scheme is that it will form a stage in plans for economic extension of electrification of main lines by creating a metropolitan line within a radius of 30 miles from Brussels, with 300 miles of track carrying two-thirds of all Belgian passenger traffic. There is a close connection between the Nord-Midi Junction, as the scheme is called, and future electrification. At present only the double-track line from Brussels to Antwerp, 28 miles long, is electrified. An agreement between the Belgian Government and the electricity suppliers has been concluded, however, to electrify the so-called "Little Star" of Brussels, formed by lines from Brussels to Charleroi, Ottignies, Louvain, Alost and Braine-le-Comte, in all 110 miles. In turn, the "Little Star" forms a part of a bigger scheme, the "Big Star," planned to electrify a network of lines from Brussels to the larger Belgian towns, such as Liége, Namur, Mons and Gand, totalling 310 miles of line. Although obviously of great value to the Belgian economy, the complete scheme, the cost of which has been estimated at some 15,000,000,000 Belgian francs (£86,000,000), must be related to the financial resources of the country.

Works in connection with the Brussels North-South Junction itself are now estimated to cost 3,400,000,000 Belgian francs (£19,500,000), and owing to various delays it is expected that they will not be completed until the end of 1950. It is hoped that the new line will be put into service early in 1951. Earthwork amounts to about 2,500,000 cubic yards, and large quantities of steel and concrete are required for the tunnels and viaducts. Work on the scheme was begun before the war, but was stopped during the occupation and was resumed only gradually after the liberation of the country.

* Former Permanent Way Manager, Belgian National Railways.

Outline of Scheme

Essentially the junction line comprises a viaduct of about 1078 yards leaving the Midi station, followed by a tunnel 2130 yards long, and a second viaduct of 219 yards to connect with the Nord station. Traffic is estimated to be 800-1000 trains daily, at intervals of two minutes, so the tunnel has been designed to accommodate six tracks, two of which will serve the Brussels-Antwerp electrified line. The neighbourhood through which the line is being built, as well as the area immediately above the tunnel, has been subjected to a town planning order, and



TYPICAL CROSS SECTION THROUGH TUNNEL

numerous modern buildings will be constructed on the tunnel roof and nearby to replace buildings demolished to make way for the line. Provision has been made in the design of the tunnel, which is being built by cut-and-cover methods, for car parks on an upper floor above the train level.

As already mentioned, the intermediate Halte Centrale will be a new station, to serve the business centre. It will be on the lines of a "tube" station, with arrangements to permit rapid movement of passengers during peak hours. Brussels North station will be entirely rebuilt, at a level 26ft above that of the present station, and at a distance of about 1000ft from the original building. Instead of a terminal, it will be a through station, with twenty-four platforms, of which twelve will be for through traffic. The more important station, however, will be Brussels-South, where passenger trains will be marshalled and originated. It is to have twenty-four platforms, of which eighteen will be for through traffic, and will have to be completely rebuilt, in this case at a level 19ft 6in above the existing track level.

Construction of Tunnel

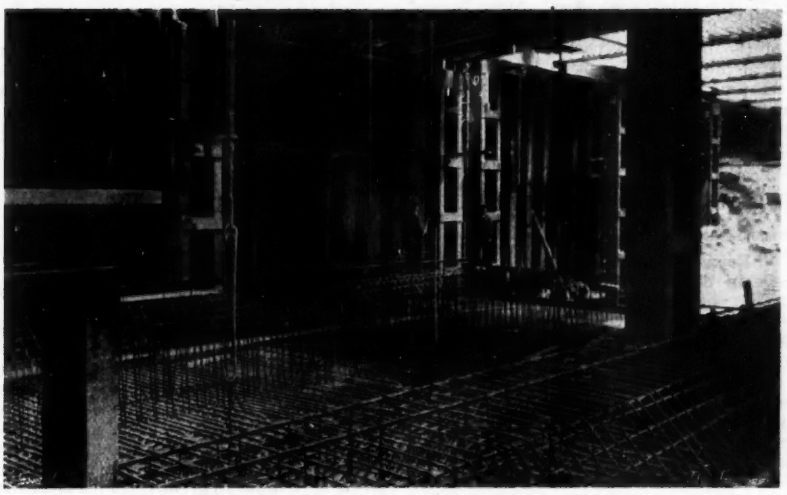
A typical cross-section of the tunnel is reproduced herewith. The depth of the excavation is 55ft and its width 115ft. Photographs reproduced illustrate work in progress. About half the tunnel has now been completed. Materials required for the tunnel amount to 20,000 tons of sheet steel piling, 70,000 tons of steel sections and 650,000 cubic yards of concrete; and the volume of excavated earth will total 1,300,000 cubic yards.

The excavated area consists mainly of shifting sand, and excavation had to be carried out within sheet pile walls, up to 80ft deep in places. This piling was left in the ground after completion of the work, as withdrawal might have caused disturbance of the foundations of nearby buildings.

The method of carrying out the work was novel and found to be successful; it was devised by Monsieur E. Franchimont,

BRUSSELS NORTH-SOUTH RAILWAY

HALTE CENTRALE SITE



REINFORCEMENT FOR A SECTION OF THE TUNNEL

ARRANGEMENTS FOR MOVING SIGNAL BOX

director-general of the "Office National pour l'Achèvement de la Jonction Nord-Midi," abbreviated to the initials "O.N.J." Briefly, the method used was, first, to excavate a layer of soil across the width of the tunnel to a depth of about 7ft, and to drive sheet piling on each side of the tunnel. These piles varied from 23ft to 29ft in length and succeeded in lowering the ground water. Foundations were then sunk for steel columns which supported the shoring, by excavating shafts to a depth of 5ft below the tunnel floor level. The columns were placed in their final positions standing on concrete blocks poured in the bottoms of the shafts. Transverse girders were then erected and assembled with the columns, so that the resulting framework, in addition to acting as shoring, formed the skeleton for the reinforced concrete of the completed tunnel.

New Stations

The new North station, in addition to serving the six lines of the Junction system, will serve the needs of through traffic. Access to the station hall will be by ramps and a platform situated 15ft above street level. There will be three thoroughfares under the tracks, of which the central one will be for passengers arriving at the station, and the two outer ones for passengers leaving the station. As the track level will be above street level, the opportunity is being taken to link two parts of the city, separated at present by the existing station and tracks, by road subways, and thus improve road traffic flow. On the railway operational side, the Belgian National Railways will modernise signalling and other equipment, so as to permit higher train speeds, especially on the Brussels-Antwerp line, which will be carried on a viaduct outside the new North station, so permitting Brussels-Namur trains to pass on lines below.

The six tracks of the Junction system will also be served by a part of the new Brussels South station. New works and buildings will include thirty-four sidings for passenger carriages, and a depot for 150 locomotives, with all necessary equipment and auxiliary buildings. All railway plant existing at present at Schaerbeek and Forest-Midi will be either demolished or altered and rebuilt at a higher level.

As it is impossible entirely to close either of the stations during reconstruction, it was decided to proceed in stages, by reducing traffic by 10 per cent and, at the same time, reducing facilities and station plant by 25 per cent; for example, the ten main tracks entering the North station have now been reduced to eight, whilst rebuilding is in progress. The necessity for keeping the stations in use decided the manner in which works were carried out, which, briefly, consisted of completing the reconstruction in longitudinal sections, of four-track width at the North station and of six-track width at the South station. The first stage of this method comprised the closing, demolition and clearing of a section four or six tracks wide; the building of a section of viaduct to the new level and the laying of tracks at that upper level. As soon as this section had been opened to traffic the second section alongside at lower level was demolished and rebuilt in the same way, and so on for the other sections until completion of the works.

The method was simple, but was difficult of practical application. Connections had to be provided for passengers and luggage, and the tracks at upper and lower levels had to be connected with access tracks. Numerous and complicated problems in connection with the permanent way and signalling arrangements arose, but were solved by the engi-

neers. Safety of traffic had to be maintained, resulting in almost continuous alterations to signalling equipment, which were both costly and difficult.

Works at the North station will be completed in seven stages, whilst those at the South station will be done in five stages.

An accompanying illustration shows the shifting of a signal-box some 75ft from its original position to suit the new lay-out. By so doing it was found possible to avoid destroying the existing box and building a replacement. This signal-box weighs 150 tons and the whole operation was completed in fifteen days without untoward incident. To move the box, a framework was built from four steel beams resting on timber work, supported on the old foundations at one end and on new foundations for the signal-box at the other end. Intermediately support was given by timber piles. The signal-box itself was supported on two deep steel beams, at right angles to the main framework, as shown in the illustration, with rollers interposed. When all was ready the original supporting columns of the signal-box were cut and the structure was moved to its new position by hydraulic jacks.

The "Reina del Pacifico" Explosion

Court of Inquiry Findings

ON Saturday, June 5th, the findings of the court of inquiry, which was set up by the Ministry of Transport to make an investigation into the circumstances attending the explosion, resulting in the death of twenty-eight persons, which occurred in the engine-room of the motor passenger liner "Reina del Pacifico" when undergoing sea trials off Belfast Lough, on September 11, 1947, were delivered by the Commissioner, Mr. J. H. Campbell, K.C., R.M., in the Belfast Summons Court. It will be recalled that the Commissioner sat with three assessors, Mr. I. J. Grey, marine consulting engineer and surveyor; Mr. John Lamb, chief marine superintendent of the Anglo-Saxon Petroleum Company, Ltd.; and Mr. W. L. Nelson, the superintendent of the Eagle Oil and Shipping Company, Ltd. The hearing extended over twenty days.

Mr. Campbell read the answers to thirty-five questions put to the court by the Ministry. He said that, in view of the conflicting nature of the evidence given, the court was not prepared to hold that the explosion in the outer port engine was caused by, or contributed to, by any wrongful act on the part of any servant of the owners, the Pacific Steam Navigation Company, or the builders, Harland and Wolff, Ltd., except in so far as disclosed in the answer to the nineteenth question on the responsibility for the manning and running of the main engines. The court did, however, criticise the divided control and responsibility which existed in the engine-room when the explosion took place.

Annexe to the Findings

In an annexe to the findings of the court, read by Mr. Campbell, K.C., reference is made to the construction of the ship and her engines and her safety and fire-fighting equipment. A full illustrated description of the "Reina del Pacifico" and her main and auxiliary propelling machinery, with drawings, will be found in our issue of April 3, 1931. We may recall that the main engine-room has a mean length of 83ft and is 76ft in width, having a height of 28ft, with a light and air casing 40ft long and 17ft wide, which extends upwards to the skylight. There are four independent engines placed abreast, each driving its own propeller direct. Each engine has twelve cylinders, 630mm (or 24·8in) bore and 1200mm (or 47·24in) stroke, the designed service power being 16,000 b.h.p. at 130 r.p.m. The engines are of B. and W.-Harland and Wolff, four-stroke, single-acting, trunk piston type, the cylinder pressure being charged by exhaust gas turbine driven blowers. Mr. Campbell says that a glance at the history of the vessel will indicate that overheating of the trunk type pistons was always a probability, especially when fitting new liners or pistons and liners. There was evidence of minor crankcase fires occurring on at least three occasions, which were directly attributable to overheated pistons. The engineers in the ship were alive to this danger at an early date, and the measures to be taken to cool the overheated parts.

The Explosion

The incident of September 11, 1947, took place after the engine had been running for close upon thirty hours after an extensive overhaul. During that period full power had been developed for the last six and a half hours. In that period there was nothing untoward, except that the fuel pump on No. 8 cylinder of the starboard outer engine had not functioned properly, and the defect persisted. The first indication that something was seriously wrong with any of the engines was a shout by a Harland-Wolff man that No. 2 cylinder liner of the outer port engine was hot, whereupon the control lever of that engine was immediately brought to the "stop" position by Mr. Oxburgh, the owners' chief superintendent engineer. After a few minutes, and without any action being taken to cool the overheated parts, the lever was moved to the starting position by Mr. Owen, Mr. Oxburgh's assistant. Shortly after the last movement of the control lever the explosion occurred. It is noted, however, that prior to putting the control lever to the "stop" position, the fuel valve of No. 2 port outer cylinder was bypassed by Mr. Forbes, one of the engineers of the ship.

Supervision and Procedure on Trials

The "Reina del Pacifico" arrived in Belfast for refit in September, 1946. The evidence shows that the usual procedure with regard to supervision during the overhaul of the machinery was followed. This being so, it was the duty of Harland and Wolff, Ltd., to carry out in a proper and workmanlike manner, and to the satisfaction of the owners, the various items of work enumerated on the repair list prepared by the owners and furnished to the repairers. The owners' representatives, on their part, one of whom was always present, considered it to be their duty to inspect each important part of the machinery which, included the pistons and liners, before such parts were refitted. With regard to the responsibility for the manning and running of the machinery, it is noted that the "Reina del Pacifico" was not a new ship. In the case of a new ship the manning and running is entirely the responsibility of the builders until the ship is handed over to the purchasers. When, however, the machinery of the ship has been in service for a number of years, as in the case of the "Reina del Pacifico," and has undergone a big overhaul, it is customary for a reliability trial at sea to be carried out. It is not customary, however, for such a ship to be subjected to speed trials unless some alterations were carried out which might affect the ship's speed in relation to propeller revolutions. No such alterations were made in the refit prior to the sea trials in question. When new machinery is installed it is pointed out that the builders are concerned with every part of it, but when being overhauled after service they are concerned only with the items mentioned in the repair list compiled by the owners.

Causes of the Explosion

The theories advanced during the evidence as to the origin of the explosion are discussed at some length. Reference is made to some experiments conducted by Monsieur H. Bara, the Engineer-in-Chief of the French Navy, which were directed to establishing that the crankcase of a diesel engine, when operating normally, is able to propagate flame, and that the origin of the ignition of crankcase contents can be traced to serious overheating of some moving part in the crankcase. Chemical and mechanical experts estimated that the average temperature of the port outer piston, No. 2 engine, had reached a value between 500 deg. and 1500 deg. Fah., and an analysis of crankcase contents in a similar engine revealed an oxygen content of the order of 20 per cent.

During the seventeen years the ship had been in commission five pistons had become overheated. In the view of the court, the cause of these trunk type pistons overheating is that the diametrical clearances were made to an absolute minimum in order to avoid piston "slap" and consequent excessive noise. The original diametrical working clearance on these 630mm (or 24·8in) diameter pistons was 0·63mm, or 25 thousandths of an inch, in the way of the skirt, and that clearance had been adhered to throughout the life of the ship. The possible theories concerning the No. 2 outer port engine crankcase explosion and the spread of flame to the crankcase of the other three engines is dealt with at some length. The Commissioner says that as there is an element of doubt as to how flame from the port outer engine reached the other three engines, the court strongly recommends that the matter be pursued by explosion experts who have not hitherto investigated the problem which has arisen on the "Reina del Pacifico."

Suggested Modifications in Design

The following modifications were suggested by witnesses, with a view to preventing a recurrence of crankcase explosions in this ship:

(1) The introduction of baffles between each individual crank chamber.

(2) Complete separation of the oil sump ventilating pipes.

(3) Complete separation of the crankcase vapour extractor pipes.

(4) Re-design of the crankcase doors to permit quick inspection of the crankcase.

(5) Re-design of the explosion discs on the ends of the crankcase.

(6) Provision of a carbon dioxide gas system as a blanketing medium for the crankcase.

(7) Remote recording of the cylinder liner temperature.

(8) Increasing the diametrical working clearance of the pistons.

With regard to these proposed modifications, the court places on record the following observations:—It agrees that such alterations and additions would reduce the explosion hazard in the "Reina del Pacifico." In the case of the proposal to subdivide the crankcase, however, it feels that there would be practical difficulties. It is not prepared to say that a moderately light baffle between each chamber would have the effect of avoiding progressively increasing pressure in parts of the crankcase remote from the point where an explosion takes place. Although there is no evidence whatsoever to support the suggestion that the flame spread from the port outer engine to the other three engines by means of the crankcase vapour pipes, or the lubricating oil sump ventilating pipes, the court is of opinion that each of these pipes should be led to the atmosphere and that no two pipes should be joined.

With regard to the pistons, it says that if the diametrical working clearance is increased, as proposed at the inquiry, and each piston is provided with four lead-bronze rings, two above and two below the gudgeon bearing, it is of the opinion that the main reason for pistons becoming hot in this ship will be removed. Nevertheless, it is the view of the court that, as there are so many cylinders and pistons—forty-eight—for the normal complement of engineers to attend, some means of registering an increase in temperature of the exposed part of the cylinder liners should be adopted. It would be sufficient to register an increase in temperature of the ahead thrust side of the cylinder liners, but the dials recording the temperatures should be grouped together and situated conveniently near to the engine control stations. If the course of the flames and inflammable vapour released from the port outer engine was as stated at the inquiry, it was

probable that the pressure wave would not have reached the other three engines had the flames and vapour been able to take an upward direction soon after leaving the port outer engine. They were prevented from doing so, to a large extent, by the plated platform on either side of each engine and at cylinder head level. If those plates were replaced by open gratings any pressure wave released from an engine would be able to take an upward direction.

The alignment of the connecting-rods of these trunk piston engines was of importance if overheating of pistons was to be avoided. The alignment when the parts were at atmosphere temperatures appeared to have had proper attention, but the court was not convinced that due regard was given to the possible effect upon alignment of those parts when the unusually long crankshafts attained normal working temperature.

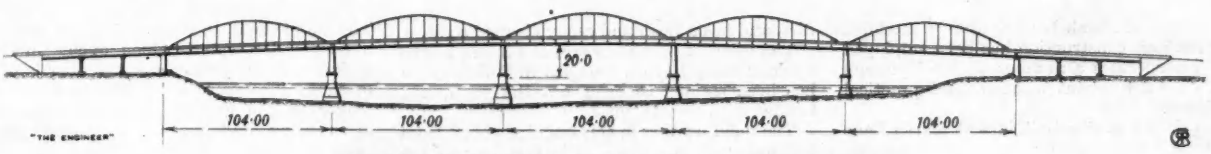
I.M.E.A. Convention

THE final session of the I.M.E.A. Annual Convention took place in the Winter Gardens, Eastbourne, on Friday, June 11th. The Association's last President, Mr. J. Eccles, who was in the chair, was supported by the presence, on the dais, of all the Past-Presidents who were able to attend. Among them were Mr. W. C. P. Tapper, O.B.E., and Mr. E. E. Hoadley, C.B.E., both of whom enjoyed the distinction of having attended the first I.M.E.A. Convention in 1895, and of being present at its swan song fifty-three years later. A short address by Mr. Eccles introduced a simple ceremony symbolising the transfer of responsibility for the welfare of the electrical industry to the British Electricity Authority. The symbol took the form of a handsome electric torch which was handed over by Mr. Eccles to Lord Citrine, Chairman of the B.E.A. Lord Citrine then spoke about the steps which had been taken by the B.E.A. since the passing of the Electricity Act, 1947. He said that the main concern during the change over had been to avoid creating unnecessary disturbance in the industry and to establish a system of control based on decentralisation. The transfer to national ownership had been accomplished with comparative smoothness and friendly relationships had been developed with other bodies and associations in the electrical industry. Lord Citrine paid a warm tribute to the valuable part played by the Annual Conventions of the I.M.E.A. in fostering friendly co-operation between the various branches of the industry. Bearing this in mind, and remembering that one of the primary functions of the British Electricity Authority was to co-ordinate the activities of the whole organisation, it had been decided to hold a conference under B.E.A. auspices in the year 1949. This conference, which would be of short duration, would be limited to representatives of the Electricity Boards and of the consumers' consultative councils. At the same time, consideration had been given to the desirability of associating this conference with a national convention, of wider scope, consisting of delegates representing all bodies concerned with the electricity supply industry. Accordingly, after consultation with the Institution of Electrical Engineers, the E.R.A. and various associations representing the interests of consulting engineers, manufacturers and contractors it had been decided to hold a national convention immediately following the conference of the British Electricity Authority in 1949. Details were still under discussion, but it was likely that this convention would be known as the British Electric Power Convention; it would be held under the auspices of a convening committee representative of all the interests involved. The advancement of technical knowledge would be one of the main objects of this convention, which would also aim at preserving the other outstanding characteristics of I.M.E.A. conventions, including the spirit of good fellowship. Lord Citrine indicated that a decision whether the convention should be held in future years would be taken after the experience gained with the 1949 Convention. He himself was confident that it would prove a valuable agency for promoting understanding and co-operation between all those concerned.

Vila Franca Bridge, Portugal

THE Portuguese Government has accepted the design and tender of Dorman, Long and Co., Ltd., Middlesbrough, in association with Seth, a Portuguese company, for a road bridge to be built over the River Tagus at Vila Franca, 20 miles above Lisbon. The complete bridge, which will cost about £1,200,000, will require approximately 3000 tons of steelwork, all of which will be rolled and fabricated in the United Kingdom. We understand that the accepted tender was the only one submitted by a British firm and that it had to meet strong competition from American, Czech, French, German and Swedish firms.

Six alternative designs were submitted by Dorman, Long and Co., Ltd. The one selected by the Portuguese Road Board consists of five steel arch spans of 104m each for the main river crossing. Including approaches, the total length is about 670m. The roadway is 9m wide and there are two footways, cantilevered out, each 1·5m wide. The general arrangement of the bridge is illustrated below, although it is now proposed to substitute reinforced concrete viaducts for the short steel approaches shown in the drawing.



GENERAL ARRANGEMENT OF VILA FRANCA ROAD BRIDGE

Acceptance of the design and tender has followed two years' work by engineers who have made frequent visits to Portugal, studying the site and evolving designs to suit the local conditions. The construction of the bridge is expected to take 3½ years. The Portuguese company, Seth, will be responsible for the construction of the substructure and the reinforced concrete viaduct approaches, which together amount to approximately 50 per cent. of the value of the work.

The Vila Franca Bridge will be the largest bridge structure to be undertaken by the company since the war. It is significant in assessing prospects for export work of this class that a British firm has been successful in world-wide competition.

Steel Production in Europe

THE Steel Committee of the United Nations Economic Commission for Europe has recently concluded a session at Geneva, at which a thorough survey was made of the factors which are retarding steel output on the Continent. Fifteen European countries were represented at the meeting, at which there were also present delegates from the Union of South Africa and the U.S.A. Mr. P. R. Bentz Van Den Berg, Director-General of the Royal Dutch Iron and Steel Works, was elected chairman.

Unanimous agreement was reached upon a principle for allocating metallurgical coke availabilities during the third quarter of this year, a step which, it was felt, would have excellent effects on European steel production. The Committee outlined a programme by which certain quantities of domestic coke would be diverted to metallurgical uses. It was appreciated, however, that the limited supply of coke could be stretched further by increasing the quantity of scrap used in iron and steel furnaces. Since there is a shortage of scrap in most countries except Germany, the Committee decided to draw the attention of the competent authorities to the scrap import requirements of steel-producing countries so that those countries might eventually have a share in the scrap to be exported from Germany. An important decision on this matter made by the Committee was that co-operative steps should be taken to increase to a maximum the collection of scrap in Europe. A panel of experts is being established by the Committee to make a country-by-country study of the scrap situation and the measures to be taken to raise scrap collection. The findings of this panel are to be reported to the Working Party on Raw Materials for Steelmaking, which will then consider whether an allocation system should be instituted to ensure the export of scrap to countries with the greatest need. The Governments of the United Kingdom, Belgium, Czechoslovakia, France, Italy, the Netherlands, Switzerland and the U.S.A. have each been asked to appoint an expert to serve on the panel.

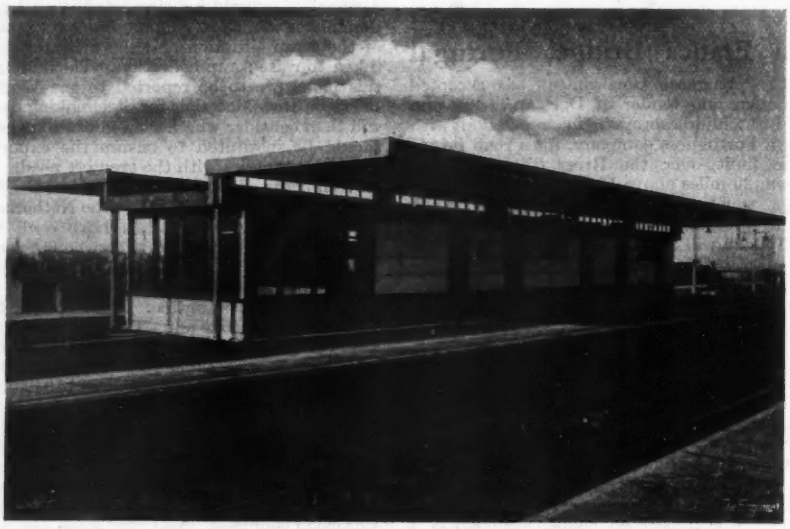
The shortage of rich iron ores and manganese ores was another matter which was fully considered by the Committee. It was pointed out that, whilst the coke and scrap situations might improve gradually, it seemed that the deficit in rich iron ores would increase in 1949 and 1950. The anticipated deficit in supplies in 1949, it was stated, was 5,500,000 tons, or 24 per cent of total European import needs. As a partial attempt to meet the situation, the Committee recommended that the main producing countries should make every effort to increase the quantities of rich ores placed at the disposal of European countries. No information was available concerning manganese ore exports from India or the U.S.S.R., and in view of the probable shortage in 1949, the Committee suggested that all the ores suitable for the production of ferro-manganese should be kept by priority for that use and should not be employed for the production of pig iron.

Finally, the Committee discussed the problems concerned with steelworks equipment. It proposed that the Governments represented should apply all appropriate measures for improving the availability of equipment to the European steel industries, a matter which was emphasised particularly by the Czechoslovak delegate. He said that without equipment for replacement and modernisation of existing plant the Czechoslovak steel industry, despite its best efforts, could not contribute sufficiently to the reconstruction of the countries which it served. The contribution which the Czechoslovak steel industry could make to European reconstruction was generally recognised by the Committee, which requested delegates from exporting countries of steel-making equipment to stress to their Governments the importance of early delivery of existing orders; to suggest measures which could be taken to ease the financing of equipment purchases; and to keep the Committee advised of action taken and progress made.

PAPER PRODUCTION IN BURMA.—A Government survey party has recently visited Arakan, on the west coast of Burma, to investigate the setting up of a State pulp and paper factory. Burma, it is stated, is particularly suitable for the production of paper as there is a total area of 30,000 square miles of bamboo, 12,000 square miles of which are economically exploitable. For the factory at Arakan the Government intends to utilise hydro-electric power, which can be obtained from the Saingdin Falls. It is estimated that in the Saingdin zone alone 75,000 tons of pulp a year can be produced.

Marsh Lane Station, Liverpool

THE new station recently constructed at Marsh Lane, on the Liverpool–Southport electric suburban line, is the first of a series designed by the architect to the London Midland Region of British Railways, based on the unit system of construction. This method, which was developed by the former L.M.S. Railway, was first used for the erection of the prototype station at Queens Park, Middlesex. In the construction of Marsh Lane station, a modified system of unit construction has been employed which incorporates a number of developments based on more recent research and practical experience.



THE NEW MARSH LANE STATION BUILDING

The original station buildings at Marsh Lane were totally destroyed by bombing, and as the station deals with a heavy suburban traffic it was one of the first to be considered for rebuilding. The scheme comprises buildings on two platforms, but only those on the island platform, which we illustrate, so far have been completed.

The accommodation in this building consists of a general waiting room, lavatories for men and women, a station master's office and a porters' room.

In conformity with the unit system, the planning has been worked out on a dimensional grid of 3ft 4in by 3ft 4in. The use of a grid of this kind is essential for the standardisation of components such as partition units, door frames, windows and equipment. It also enables the elements of the roof structure to be standardised and, in the case of Marsh Lane, the unit span for the roof decking is 16ft 8in, and columns occur at these centres. To eliminate problems of tolerance, and to avoid provision of special components, the columns have been kept free from the walls, and with the exception of those at the ends, are situated inside the building. The awning is carried on a welded steel frame. The main lateral beams to this frame are cranked, and provide continuous clerestory lighting along the length of the building, thus admitting some light to the platform when a train is standing in the station. These cranked beams at 16ft 8in centres are "top-hat" section, and carry on their lower flanges a stressed skin plywood decking unit. The plywood units are spaced 4ft apart over the building to allow for the runs of electric lighting service.

Materials generally have been specially chosen to stand up to railway conditions. Externally, the most serious conditions are those arising from severe atmospheric pollution and damage from platform barrows. Below cill height, where damage from barrows occurs, the walls are finished with precast concrete slabs, with an exposed granite aggregate. Above cill height the principal requirement is clearly a material which can be easily washed down, and in this case vitreous enamelled steel panels in a light straw colour have been selected. The finish is permanent, and requires no maintenance, its colour remaining clear with nothing more than regular washing down. In order to keep maintenance work to a minimum, door and window frames have been built of Empire hardwood and left unpainted. The only painted area of any appreciable size is the underside of the awning, which is unlikely to accumulate dirt, and has a flush and easily cleaned soffit.

The internal partitions and the lining to the exterior walls have a Douglas fir finish which has been stained to bring out the grain, and treated with a matt polish.

The main heating in this building comes from hot water pipes embedded in the floor of the structure. The electric wiring has a series of main longitudinal runs in the ceiling along the lines of the grid and provides a completely flexible and easily accessible lighting system.

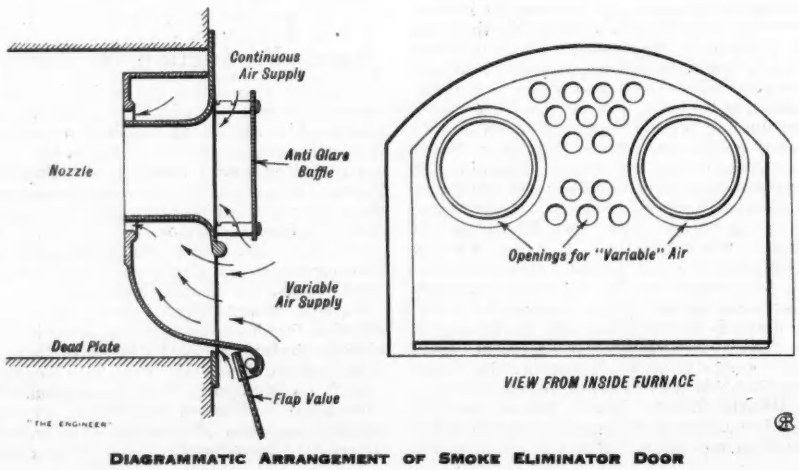
A Smoke Eliminator for Natural Draught Boilers

AN intensive investigation was carried out during the war at the Fuel Research Station of the Department of Scientific and Industrial Research to determine a means of preventing heavy clouds of smoke emerging from the funnels of coal-burning ships. It was found that one of the principal causes of this smoke was that the furnace equipment in use did not introduce sufficient air over the fire to burn all the volatile matter distilled from the fuel bed immediately after firing certain types of coal. Once this fact was established a smoke eliminator was designed which provided means whereby additional air was introduced to promote the combustion of the volatile matter during the periods it was produced. In tests with these smoke eliminators fitted to a marine boiler on land it was found that not only was the production of smoke stopped but that a definite economy was effected in fuel consumption.

When the war ended the attention of the station naturally turned to the development of commercial equipment which could be fitted to the furnaces of natural draught hand fired land boilers, both for the purpose of smoke abatement and as a fuel economy measure. As a result of this work a furnace door incorporating the smoke eliminator has been introduced and is being manufactured by the Grooved Firebars Company, Ltd., 52, Grosvenor Gardens, London, S.W.1, and Cleveland Meters, Ltd., Trunk Road Engineering Works, Redcar, Yorks.

This door, a diagrammatic arrangement of which we reproduce, is in the form of a hollow metal box in the upper part of which are two large orifices or nozzles through which jets of air pass continuously without obstruction into the space over the fuel bed. A flat plate over these nozzles, on the outside of the door, is designed to shield the eyes of the stoker from the glare of the fire. This plate is located on notches in four supporting pegs, and it can be set in any convenient position in relation to the front of the door. The additional air which is required to burn the volatile matter immediately after firing or raking enters the box through a wide rectangular opening at the base. This air passes upwards round the nozzles, to enter the furnace through an annular opening surrounding each nozzle. A further supply of the air passes to the fire through a number of holes on the furnace side of the door. The supplementary air supply is controlled by a simple flap valve, which opens under the action of gravity whenever the door is opened or shut. The valve is closed manually by the stoker at the end of an appropriate period after firing and when the volatile smoke-producing matter has been consumed.

Some interesting data in connection with the smoke eliminator were given by Mr. T. F. Hurley, in a paper read before the Institute of Fuel and the National Smoke Abatement Society, in August, 1947. A series of trials was carried out on a Lancashire boiler furnace with a uniform fuel bed about 5in to 6in thick and free from holes; the fuel used in each case was Northumberland washed singles, which was known to be liable to make heavy smoke under certain conditions. When very little air was admitted over the fire, black smoke was made through most of the firing cycle and as much as 15 per cent of the heat in the fuel was lost up the chimney as potential heat in combustible gases. When the maximum possible quantity of secondary air was introduced through the grids of the fire doors supplied by the boiler makers, black smoke was only made for short periods after firing or raking



DIAGRAMMATIC ARRANGEMENT OF SMOKE ELIMINATOR DOOR

and the heat in the combustible gases was reduced to about 5 per cent. The net gain in efficiency was thus considerable, even though the amount of sensible heat carried away by excess air was increased by 2 per cent. When firing doors of the smoke eliminator type were used with approximately the same amount of excess air no black smoke was emitted and the heat lost in the combustible gases was still further reduced to about 1·5 per cent.

A Ballast Cleaning Machine

We reproduce a photograph of the "Matisa" automatic ballast cleaning machine, with which the Railway Executive is conducting trials on the London Midland Region. Negotiations for the loan of this machine were started by the former L.N.E.R. with the manufacturers—Materiel Industriel of Lausanne—some time ago, through the British agents, the Matisa Equipment Company. The performance of this machine, which automatically removes and riddles deteriorated ballast from beneath and between sleepers whilst moving along the track, is stated to have been very impressive. Its rate of progress when working varies with the depth of ballast removed, and the makers state that with a gang of eight men it can deal with about 130 lineal yards of track an hour.

"MATISA" BALLAST CLEANING MACHINE

All the automatic functions of the ballast cleaner are electrically driven by separate enclosed motors powered by a 100/120 h.p. diesel generator. The main body of the machine is in the form of a trolley about 18ft long, mounted on two four-wheeled bogies. This trolley carries most of the mechanism, including the diesel generator, the vibrating screen and the means of disposing of the screenings and the cleaned ballast.

The excavating equipment consists of an endless chain carrying scrapers and guided in a triangular frame, the base of which passes below the sleepers and parallel to them. The horizontal base member of the guide frame is slung from a small auxiliary bogie attached to the main trolley. Two adjusting screws govern the vertical position of the base member of the frame, and through them the digging depth can be set up to a maximum distance of 36in below rail level.

The sides of the triangular guide frame are tilted towards the rear and, sloping upwards, meet in a turret on the main body of the machine. In this turret is the sprocket driving gear for the scraper chain.

Material excavated from the track is deposited on a tilted vibrating screen at the rear of the machine. This screen, which separates the waste from the good ballast, can be fitted with any size of mesh according to the size of ballast it is required to reclaim.

Reclaimed ballast from the vibrating screen is deposited on a belt conveyor swivelling chute, which deposits and spreads the material back on to the track. A second belt conveyor swivelling chute takes the waste screenings and ejects them into wagons or on the side of the track.

Whilst the ballast cleaning mechanism is in operation the complete unit is hauled along the track through a steel cable connected to a winch on the auxiliary bogie at the front. This cable is anchored some distance in front of the machine and the anchor is moved as the work progresses. When the machine is travelling from its depot to the site of operations it travels under its own power at a speed of about 20 miles an hour.

An Apprenticeship Scheme

Details of a comprehensive scheme for the training of apprentices have been issued in the form of a brochure entitled "The Osborn Apprentice," by Samuel Osborn and Co., Ltd., of Clyde Steel Works, Sheffield. It has long been recognised by this company—as by many other industrial concerns—that the training of youths to form the next generation of engineers is of the utmost importance, not only to itself but to the future wellbeing of industry as a whole. For this reason it is interesting to note the carefully considered scheme which has been introduced by Osborn's, both for the selection and training of craftsmen and for the advanced training of potential supervisory staff.

The comprehensive scheme of training which has been inaugurated is in the firm's tradition of education for those taking service in its various departments. This scheme had its beginnings when Sir Samuel Osborn, after the first world war, started a "continuation school," which carried on the work of the first school started by the founder of the company in 1871. In the intervening years every encouragement has been given to the younger employees of the firm to attend the excellent evening classes which have been made available by the local authority and the Sheffield University. To this end schemes for payment of fees and awards of merit have always been provided. Despite these facilities the company considered that specialised training was necessary to equip young people for the tasks ahead in these difficult post-war years.

To formulate a training scheme an advisory committee, consisting of two directors and five senior executives, was set up. In the scheme prepared the actual training is planned and carried out by works committees, consisting of managers, foremen and shop stewards at each works of the company. A full-time training officer is employed to co-ordinate training and look after the progress of the boys.

Under the scheme each successful applicant for training first passes through an initiation and a probationary period prior to being signed on as an apprentice. A wide range of trades is available for training purposes in these works and, in addition, boys who are so qualified are given appropriate training for a commercial career. In addition to training in craftsmanship in the workshops, educational and technical instruction is given to the boys in day-continuation and evening classes. Numerous awards are given for consistent attendance and achievement in these classes. Selected youths with the necessary ability and qualifications are given an opportunity to take a post-apprenticeship course with a view to their taking positions on the firm's supervisory staff.

We understand from the firm that the scheme is working very well and is attracting the better type of boy. In addition to thirty-six full apprentices it has at present ten boys in the initiation and twenty-four in the probation stages in the works. These numbers, although short of the actual requirements, have shown encouraging results.

Railway Bridge Rebuilding in Hungary

Hungarian railways underwent extremely heavy damage during the war. Practically all important bridges were destroyed. Five long-span railway bridges were blown up over the Danube, while eight bridges crossing the Tisza River were destroyed. Despite difficulties of various kinds, especially shortage of steel, the restoration of bridges is now well in hand. According to *L'Ossature Métallique*, the progress of restoration work is now as follows: Over the Danube, the most important railway bridge was the Southern bridge at Budapest. This double-track steel bridge, composed of four spans of the lattice arch type, each 315ft long, was built in 1908–1913, and was very seriously damaged by air attacks and later blown up by the Germans. Soviet Army engineers built a temporary bridge, utilising rolled steel sections, assembled by rivets. In the autumn of 1945 the Hungarian State Railways decided to replace this structure by a semi-permanent bridge. Military bridge trusses of the "K" lattice girder type were used for the construction of this bridge, built on the cantilever principle. The bridge, designed to carry a single-track line, is composed of four spans, each 320ft long. Owing to the volume of the railway traffic on this line, a new double-track bridge, of modern design, will be built in the near future in the vicinity of the semi-permanent structure. The Zahony bridge, over the Tisza, plays an important part in railway communications between Hungary and U.S.S.R. The old structure was a lattice girder bridge, composed of three spans, each 280ft long. The bridge is now being permanently rebuilt, the cost being shared equally by the Soviet and Hungarian authorities. The heavy damage undergone by the Tokay bridge precluded its repair. The traffic which passed previously over this bridge is now using the Tiszafured bridge. The construction of this latter bridge, started during the war, was interrupted in 1944. After the end of hostilities, Hungarian authorities built a permanent steel structure, 910ft long, on both sides of the temporary bridge erected by Soviet troops, almost without interruption to traffic.

Institution of Electronics.—The third annual Electronics Exhibition organised by the North-West Section of the Institution of Electronics is to be held at the College of Technology, Manchester, on July 20th, 21st and 22nd. On the first day it will be open from 2.30 p.m. to 9 p.m., and on the other days from 10 a.m. to 9 p.m. In addition, there will be an exhibition of scientific films arranged by the Manchester Scientific Film Society. Admission to the exhibition will be by ticket only, which may be obtained from Dr. J. A. Darbyshire, "Melandra," 1, Kershaw Road, Failsworth, Manchester.

Achieving P.M.H. in Industry*

By B. H. DYSON†

We have to ask ourselves, what has industry done to engender an attitude of mind conducive to increasing production ? How have individual companies interpreted and acted on these problems in their day-to-day activities in the office and on the factory floor ?

Possibly the most disastrous element in Britain to-day is the lowering of our standard of expectancy. I believe that the attitude most dominant in industry, and in us as individuals, is that of over-complacency. We are too willing to think conditions are against us and that we cannot do much ourselves—it is always the other fellows who must do something.

How can we talk about a higher standard of living while we have a low standard of expectancy ? One usually gets less of the desired things of life than one expects—so one of the most important things in British industry to aid P.M.H. is for us—particularly production engineers—to have and expect a high standard of expectancy.

Let us be frank with oursleves. Do our foremen, do our own workpeople, know what our standard of expectancy is ? With no goal posts, there can be no goals ; with no winning post, there can be no race ; with no office, factory and individual targets, there can be no measurable P.M.H.

If we take the trouble to go to the gates of half a dozen factories any evening of the week and ask five people from each factory these three questions, I wonder what answers we would expect ?

(i) What is your company's target for production this week ?

(ii) What is your own individual or departmental target for achievement this week ?

(iii) What are the achievements to-day against these targets ?

Do you think that if applied to your own workpeople, staff, office or works, answers to these questions would be forthcoming ? If not, how can we expect good P.M.H.? What would be our own interest and response under such conditions ?

Production per Man-Hour by Whom ?

In reviewing figures indicating the distribution of manpower in Great Britain, we find that out of a total working population of just over twenty million, approximately eight million are engaged in the productive industries.

It is well known, although often forgotten, that in the majority of industrial concerns the percentage of direct producing personnel is invariably only 40 to 60 per cent of the total personnel. This reduces our direct producers to approximately four million, to support a total population of forty-nine million.

Why, then, is so much more attention given to planning and measurement of work in direct production departments only, and little or no attention to the burden ? Surely it is not more production per man-hour we require, but more efficient productivity per total man-year.

Many people have decided that Britain's need is to increase production, but how often these same people refer to the other fellow's production and forget their own low standards.

Why use analytic motion study and the measuring tool of time study on the machine-controlled factory job and the simple assembly operation, and ignore the tool-room, stores and office ? Why have elaborate machine and work-loading charts for the machine shop and yet not know the capacity and commitments of the drawing office or inspection staff ?

Consider the repetition job of the storekeeper selecting components from the stores bin ready for issue to the assembly department. I wonder how many companies, considering themselves efficient, have even troubled to find out how many selections the storekeeper should average per hour. How do you decide the number of storekeepers you require, or that your direct operators can support ? What is the ratio of your total operating cost in relation to direct productive and total personnel ? Or do you forget the ninety-nine indirect and rejoice in the one direct to be found producing P.M.H.?

Of course, we might also ask " P.M.H. for what ? " We will readily get the answer—" For export ; for a higher standard of living ; for food and survival " ; but what we really mean is—at a competitive price. In fact, in the very near future (I might even say to-day) the problem is not " how much P.M.H.? " but " P.M.H. at how much ? "

Review the build-up of the cost of our products and what do we find ?—55 per cent of the cost is material. So, it may be a better proposition to study effective P.M.H. in our engineering department, our purchasing department and our stock control department than in the press shop or capstan section.

Who are the managers responsible for P.M.H.? Too often we only think in terms of general managers, works managers or production managers. How about the office managers, the departmental chiefs, supervisors, foremen, section leaders and chargehands ? They all manage men—or, in other words, are responsible for the achievement of P.M.H. Have they, by selection and training, been fitted for leadership conducive to the achievement of maximum P.M.H.?

The Importance of Good Leadership

The majority of people are led into action. All people like a leader and will respect and follow good leadership. If the official leader fails, an unofficial leader will soon influence the working group. People are not enthused with a company or organisation, a party or policy, but by management leaders.

I can quote you an instance of a certain department in which the plant, equipment, product, personnel—yes, even payment—remained identical, the only change being in the manager, and production increased by 17 per cent ; or another case in which the same product produced with identical equipment and tooling, was transferred from a group of people working on a payment-by-results scheme to another factory with less experienced labour on a straight wage payment, and P.M.H. increased by 8 per cent. The departmental manager was, however, a real leader.

P.M.H. is not achieved just by men with good ideas, but rather by men who can make ideas work ; in fact, on a check made in U.S.A. it was found that on average 10 per cent of people have good ideas, but only 3 per cent can make ideas work. Industry requires managers with the ability to get things done ; to enthuse teams of people with the attitude of mind, not only willing, but desiring to give of their best.

Management Technique

One of the best ways of ensuring that your workpeople are willing to be versatile and not restrictive is to initiate that type of supervision. Promote from one department to another, broaden the outlook of your supervision, get away from the narrow departmental interest and promote an organisation interest—let it be demonstrated that promotion is not restricted to one department, but organisation-wide. We have adopted this policy in recent years, and it has had a marked improvement on P.M.H.

Another change in management technique which has shown remarkable results is that of presenting all departmental efficiency not under a departmental name or number, but against the name of the manager. For instance, we no longer state the direct productive efficiency for the capstan section, but, as Mr. Johnson's efficiency ; we no longer show the weekly scrap report as value of scrap of the Bakelite section, but as Mr. James' value of scrap.

Also, at our weekly Monday morning production progress meeting, at which our production superintendents, chief inspector and purchasing manager attend, each superintendent states his production achievement against his target, and explains why if he failed, and also explains his problems and how he intends to overcome them in the ensuing week. This has proved much more effective than receiving these figures and the position from some indirect recording department.

Planning to Achieve P.M.H.

Designing for production is possibly the first step to increasing P.M.H.; in fact, the drawing board is the cradle of production costs, and it is total production costs which really matter. If the design of the product is not efficient from a functioning and productive standard, then no matter how perfect all other aspects are, P.M.H. is wasted. P.M.H. is frequently held up because dimensional standards are not defined, or are not consistent with the actual requirements. Surface finish is left to personal opinions, and specifications regarding appearance, noise, vibration, &c., are controversial.

Administrative departments untuned or out of step with production requirements can seriously affect P.M.H. We hear a lot about Government Ministry paper work and forms, but most industrial paper work and forms have a lot of P.M.H. to answer for. Have you ever listed down the number of forms which are made in your organisation—from the receipt of the customer's order to the despatch of the goods ? Have you ever checked up on a few of your factory forms to see how they are actually filled in and used ? A definite routing and understanding of procedure and flow of information written down in a flow chart, illustrating and explaining the movement of all the more important documents from department to department and even from person to person, might amaze us. A time study check on the distance that paper work travels and the time involved to fulfil the function, might suggest a redesign of most industrial forms, or, in fact, a complete elimination. There is no reason why much routine office work should not be flow lined in a logical sequence from one office worker to another, just as an assembly operation.

Also, the people responsible for production policy and procedure must not limit their views to " floor-to-floor " times, but to all embracing aspects " from door-to-door "—the material supplier's door to the customer's door. Have you ever observed and recorded the amount of unnecessary P.M.H. involved from the unloading of material from your supplier's truck to the time it reaches the first production operation, or recorded the time involved ?

Again, one might question, " How do we plan the control of P.M.H.? " I am convinced that visual control on the office and factory floor is the only real control, and the lay-out of offices, machine shops and assembly departments must be such that it will facilitate this control. Can the supervisor stand in the centre of his department and see what is happening to P.M.H.? If not, he cannot control.

I am convinced we spend far too much time recording on paper the movement and results of work in process, and then investigating and criticising the inefficiencies after it has happened, rather than doing something about it while it is actually happening.

Again, how often a good deal of attention is given to the selection of machine tools and the design of tooling, but little or no time and attention given to ordering those replacement spares such as packing glands, leather cups, fabric belts, valves, &c., which will naturally wear and cause a breakdown, resulting so often in loss of P.M.H. while replacements are being made or obtained, sometimes from overseas ?

If there is a routine check during the meal break or week-end period of continuously used tools and plant, or a procedure followed by returning tools with the last component produced at the end of the production run *via* a tool inspector located in the tool stores, a considerable improvement will result.

Production Engineering and P.M.H.

Observation will teach us that in those countries where P.M.H. is higher than in Britain, people do not work harder but more continuously and more effectively. Particularly is this true in respect of more horsepower to their

* Institution of Production Engineers, Conference on P.M.H., Wolverhampton, May 22nd.

† Works manager, Hoover, Ltd.

elbow—the office worker's, the toolmaker's, the electrician's and carpenter's elbow as well as the production operator's. So often, even in a well-equipped production factory, we find office workers without the simple adding or calculating machines, but even worse, we find electricians and carpenters still using hand tools when power portable tools are available.

No, we do not have to go to America or any other country to see and obtain this production equipment—we may have to go there to see it used. Even with machine tools, although the average age in British industry is twenty years, in the U.S.A. 33 per cent are over twenty years and 66 per cent over ten years; yet in this country there are factories where the machine tool average age is only six years.

Even after we have modern machine tools and efficient tooling, P.M.H. can be made or marred according to whether consideration is given to such things as the most economic length or condition in which the material should be purchased; how long it will take to set up the machine; or the capacity and commitments of the work load on the various types of machine, &c.

So often the man who can make or mar the production effort (regardless of machine tool or equipment)—the setter—is ignored. What about his work place and equipment—or has he any? On a particular accurate machining job the set up time was five hours for a production run of fifteen hours. When a setting fixture was made and used the set up time was reduced to two hours.

How often we make the error of supplying the inspector with checking gauges of a higher standard than those supplied to the setter, or with gauges set to closer tolerances than those supplied to the operator. The reverse procedure could result in overcoming much lost P.M.H. because you cannot inspect quality into a job.

So often we neglect to define in our process operation sheet the inspection operations, stating in detail the dimensions and points which really need to be checked. To motion study a production operation and ignore the work place and equipment supplied to viewers is surely only paying lip service to the important job of inspection. Wherever possible, viewing and inspection operations should be carried out in the production flow line or production section, rather than in some remote inspection department.

Creating the Desire for Achievement of P.M.H.

I believe the scope under this heading is greater, and the results more immediate and lasting than any other aspect of P.M.H. Let us just review three aspects which are so often talked of: (*a*) Incentives, (*b*) joint consultation, and (*c*) social status.

(*a*) *Incentives.*—We hear a lot about incentives to increase P.M.H. Incentives for whom—the managers, supervisors, technicians, designers, office workers, craftsmen, storekeepers, or only for machinists and assemblers?

I believe all the multitude of incentives can be grouped under three main headings.

"*Must*" *Incentive.*—Often from the motive of fear—must work to live, to keep the job, must export to get a licence to manufacture. It is doubtful if this can sustain effort—it is outmoded.

"*Should*" *Incentive.*—With the motive of high ideals—we should be good people; we should work harder; we should save; we should not use petrol, tobacco, coal, &c. This is too idealistic, too remote, not close enough to the majority of individuals to really mean anything to them.

"*Desire*" *Incentive.*—With the motive of personal enthusiasm. If we really desire something (it may be desire of knowledge, of achievement, of possession) this is possibly the only real incentive. When we really desire something we apply spiritual, mental and physical energies. How do we capitalise on this in industry? First of all people desire to belong to a successful undertaking, no matter if it is a cricket team, dart club, or a company, we like to be associated with success.

We have staged several production campaigns, based on the desire of achievement, with outstanding results—one such campaign was held last year. Our object then was to counteract the feeling of depression resulting from the fuel crisis, and to give our employees the feeling that they belonged to a growing, prosperous company. Our target was to catch up on all production losses through the fuel crisis, and in the final week of the campaign to beat the record weekly production of our associated American factory. Over the campaign we achieved 107 per cent of the target set, which represented a 27 per cent increase over previous output figures. Direct operator efficiency increased by 8 per cent and total absenteeism fell from 6 to 4 per cent. We beat the weekly output record of the American factory for one week in the final week by several hundred machines.

(*b*) *Joint Consultation.*—We have all heard a lot about this. First, one might ask, "Who is to consult who—about what?" Beware of over-consultation—consultation for consultation's sake; beware of "two-party" consultation, especially if it is between management and shop stewards—like insurance, third party coverage is safest—don't forget the supervision. Consultation which builds confidence cannot result from remote control, or from people split into sides. Consultation results depend on the confidence in action by individuals. In fact, joint consultation on the office and factory floor is the only real joint consultation—for this reason we have our works committees, elected and operated on a floor basis, with the meetings held on the floor concerned.

How about joint consultation between the directors and managers, between management and supervision, between design and production staff? To cover this essential consultation we hold management meetings in the various factories on a rota basis; also link meetings in order to link supervision with management in a two-way passing up and down of knowledge, policy, trends, &c. Possibly less closed doors and secret process between industry, and more interchange of ideas and development might be the joint consultation to give higher P.M.H.

A crisis, conflict or strike is usually due to misunderstanding. There are usually three ways of dealing with all incidents: Immediate domination, which results in a fight; explanation of differences, from which compromise can result; prior consultation, remove suspicion by understanding. But beware, it is not that which goes into the ears that matters, but what takes place in the heart. Industry has to appreciate that people like the opportunity for self-expression; they like to feel they matter, that their views and reactions on working conditions are of interest and value.

One of our shop stewards put forward the suggestion that when we were going to re-lay-out a department, a drawing of the new lay-out should be displayed in the foreman's office, and the results of this procedure have been excellent.

Again, whenever we develop or purchase new plant or equipment, the supervisor, chargehand and operators go to see it, and are acquainted with it before it is installed. We have been amazed at the results of this kind of joint consultation.

(*c*) *Social Status.*—What is industry doing to create the desire for P.M.H. achievement by raising the social status of those who produce, such as creating pride in the job, creating interest in the community, in the home, in the schools, yes, even in the church? Or is the easy line of least resistance, the negative approach, one of the causes of low P.M.H.? Unfortunately, the recent Government poster "We work or want" had every ingredient of being negative—almost the same words rearranged would have given a positive approach, "We want to work." Or is the trouble that we have in Britain debased rather than glorified work—is there no dignity in a job of work? The man who goes to work at 9.30 a.m. and returns home at 5 p.m. is said to have a good job. The neighbours who peep through the bedroom curtains at the works manager who sets out to the job at 7.30 in the morning say, "Poor devil, what sort of a job has he got?"

But then in industry we have the skilled toolmaker starting at 8 a.m. and the unskilled girl clerk starting at 9 a.m. We give her two weeks' holiday with pay; she does not clock in and she is paid should she be absent from work on account of a headache. What does the craftsman think of this? Does it warrant an apprenticeship to be laid off when there is a fuel crisis, or a change in production lay-out, when the unskilled clerk has continuity of employment? Recently we have raised the status of our chargehands by a weekly salary, holiday and illness payment.

We have just completed a five-week campaign which put to the test the effectiveness of our joint consultation, which displayed the power of leadership of our supervision to use that desire of achievement incentive to the full, to create the pride of workmanship and to raise our standard of expectancy by new high targets. We held a campaign to "Make the Most of Materials"—asked for suggestions from everyone on the better utilisation of materials, and received 4850 suggestions in five weeks—equal to eight years' normal response—to what we considered was a live scheme; reduced our scrap percentage from 2 to 1·28 per cent, representing 29,000 more hours per annum; reduced our faulty work by applied operators' interest and skill, representing a saving equal to 10,250 man-hours per annum; reduced the usage of indirect materials, office supplies, oil, gloves, rag, flex, &c., to the value of £23,000 per annum.

The campaign opened with the sending of a personal letter to the home; by competition targets between the works committee floor divisions; by displays of good suggestions; by examples of the results of faulty work; by demonstrations of the correct use of indirect materials.

Conclusions

It is reasonable to state that to production engineers there is no real insurmountable problem in production techniques. It is safe to forecast that no revolutionary production process or machine tool at present unknown will suddenly, or even over the next five or ten years, revolutionise P.M.H. But I believe we could, in a matter of months, surprise not only ourselves, but those who talk of P.M.H., if we put into action:

(1) Managers at all levels with the ability to get things done by people desiring to give of their best.

(2) Raise and decide the standards of performance we expect.

(3) Set targets for achievement with time, quantity and quality elements—for all individuals.

(4) Correct our ratio of indirect to direct production personnel.

(5) Design for ease of production, as well as for functional efficiency.

(6) Production planning for "door-to-door" efficiency—the material supplier's door to the customer's door.

(7) Ensure that the conditions of the work place and the equipment to be used are equal to the job expected.

(8) Create the incentive that results in the desire of achievement, and the rejection of restrictive practices.

(9) Raise the conditions to increase the social status of those whose job it is to produce.

(10) Have a standard by which to measure the effective results of P.M.H.

An Adjustable Spanner.—We have received from International Engineering Concessionaires, Ltd., 25A, Kensington High Street, London, W.8, a sample of a new "Grip Adjustable" spanner, which is now being made in three sizes, 4in, 6in and 9in. The two smaller sizes have zinc base alloy bodies with hardened steel jaws and the largest size is of all-steel construction. In these tools the shank of the movable jaw passes through the hollow body and its lower threaded part screws into a well-proportioned knurled sleeve. This sleeve gives a particularly good purchase when tightening the spanner on a nut and the design is such that there is no play or slackness in the jaws. Means are also provided to increase the pressure applied through the sleeve by use of a coin or a tommy bar. We have found the spanner efficient in use, and its effective grip, combined with an entire absence of play in the jaws once they are set, make it a useful adjunct to any tool kit.

Industrial and Labour Notes

The Coal Situation

A review of Britain's coal situation, which included some observations on coal exports, was presented by the Minister of Fuel and Power, Mr. Hugh Gaitskell, at a Press conference in London on Thursday of last week. He said that in the six months of the coal winter, which ended on May 1st, the total output of coal was 105,400,000 tons, which was 7,600,000 tons more than in the preceding winter. Production of deep-mined coal during the winter was 99,700,000 tons, or 5,700,000 tons above last winter's total. The main reason for the increase in the output of deep-mined coal, Mr. Gaitskell stated, was a rise in output per manshift from 1·05 tons to 1·11 tons.

Inland coal consumption amounted during the winter to 103,000,000 tons, which was 5,200,000 tons less than the total provided for in the coal budget, and by the end of the winter the total for exports and bunkers had reached 4,800,000 tons, or 2,000,000 tons more than had been estimated. Nevertheless, the Minister continued, total distributed stocks at the end of the winter were 13,100,000 tons, or 6,540,000 tons more than had been expected.

Commenting on the prospects for the remainder of this year, Mr. Gaitskell said that there had been some disturbing tendencies in the figures both for coal production and consumption in the last few weeks and, indeed, since Easter. Taking the period since May 1st the first five weeks of the coal summer, 18,600,000 tons of deep-mined coal were produced, which, on the average, was 100,000 tons a week short of the amount required for the achievement of the year's target. Before Easter, the output of mined coal had averaged nearly 300,000 tons a week more than in the corresponding period of 1947, but since Easter the excess had fallen to only 50,000 tons. As to the reasons for the decline, Mr. Gaitskell explained that manpower had not increased much since March, while output per manshift, which had averaged 1·11 tons throughout the winter, had been only 1·09 tons for the first five weeks of the summer. Attendance at the mines had not improved since the winter as much as it should have done, and the output of coal in the extra Saturday shift had been well below the level obtained during the winter months. On the other hand, opencast production had exceeded expectations, but, the Minister emphasised, the consequences of not reaching the target for deep-mined coal would be most serious.

Coal Consumption and Exports

As mentioned in the preceding note, the Minister of Fuel and Power included in his review some observations on coal exports. He also commented on present trends in inland consumption, saying that in the first four weeks of this summer 13,770,000 tons were used in this country, or 4·6 per cent more than in the corresponding weeks of last year. The greatest increase was in coke-oven consumption, where, to meet the needs of the iron and steel industry, coal requirements had been 16·4 per cent higher than a year ago. In addition, Mr. Gaitskell stated that coal consumption in recent weeks by electricity stations and gasworks had exceeded expectations by 6·4 and 4·3 per cent respectively. Bearing in mind the forthcoming winter stock requirements, Mr. Gaitskell pointed out that if output was lower or inland consumption higher than it should be, there would be no alternative but to reduce the rate of coal exports.

From now onwards, Mr. Gaitskell continued, coal exports should average 350,000 tons a week if this year's target of 15,000,000 to 16,000,000 tons was to be achieved. The great bulk of our cargo exports, he explained, was regulated by bi-lateral trade agreements with foreign countries. The National Coal Board had still to negotiate with the countries concerned contracts for the sale of coal, and considerable difficulty was being experienced in making available for export the qualities of coal which foreign customers would like. This year, it was pretty clear that, if detailed consumption programmes were compared with the probable output of different sizes and grades of coal, there would be a serious deficiency of large coal and a surplus of small uncleaned coal. If, however, the year's target for deep-mined coal production could be reached, it might just be possible to fulfil the export programme without cutting supplies of large coal for home industries and consumers. If, however, we failed to reach the deep-mined target, Mr. Gaitskell concluded, either exports or home consumers' supplies were bound to be cut.

Manpower Distribution

The thirty-first session of the International Labour Conference opened in San Francisco yesterday, the first item on the agenda being the presentation of the report of the Director-General, Mr. Edward Phelan.

One section of the report discusses trends in social policy and comments on manpower distribution and employment organisation. Remarking that principles have been formulated to govern manpower utilisation and distribution, the report says that measures based on those principles have been accepted in countries in many different parts of the world. What seems now to be needed, above all, is a further development of the practical ways and means of carrying out those measures in conformity with current national requirements and with respect for the rights of the workers. Greater attention, the report claims, is now being given to a basic part of employment policy, which has been somewhat neglected in recent years—the organisation of employment at the local level. It is more fully realised that if manpower problems are not approached and dealt with effectively at this level, it is idle to expect significant results from the application of general policies recommended nationally or internationally.

The report goes on to say that, in spite of the mobilisation of labour reserves, most countries with full employment have not found it possible to mobilise within their own frontiers an additional supply of workers sufficient to satisfy the heavy demands for labour for industry and agriculture. The need has been for greater mobility of labour, both occupational and geographical. It is felt that public education with respect to manpower requirements and their relationship to economic development has been very much intensified during the past year in a number of countries. In Europe, according to the report, it is estimated that measures aimed at the more effective use and distribution of national manpower resources have reduced the overall manpower requirements by several hundred thousand workers. It is realised, however, that much more can be done, one recommendation being a continuation and intensification of measures designed to attract workers to essential employment.

The A.E.U. National Committee

The annual meeting of the Amalgamated Engineering Union's National Committee began at Brighton on Monday last with an address by the president, Mr. Jack Tanner, who touched upon several matters to which both sides of the engineering industry are at present giving a good deal of thought. Among them was the steel industry, on which subject Mr. Tanner said that the benefits to be derived from nationalisation depended largely upon its administration and primarily upon the work of those engaged in the industry. It might be that temporary dislocation was unavoidable, but that was not a reason for abandoning or delaying nationalisation. The nationalisation of our basic industries, to enable them to undertake the formidable tasks ahead of them in the general reorganisation of production, was, he thought, essential at the earliest possible moment.

In another part of his speech, Mr. Tanner commented on the campaign for increased production, saying that the Government had spared no effort in a most exhaustive search for every aid and every incentive for the purpose. In the last analysis, however, it was the operator, the man at the bench or the machine, who had to make the extra effort, as it was from his hands that increased production must come. After reference to the extension of joint production committees, Mr. Tanner urged that the trade union movement must keep the ultimate objectives in view, one of the most important being the control of industry. Progress, he said, must be stage by stage, and joint production committees must be regarded not only as a most necessary and suitable means of surmounting immediate economic difficulties, but also as one, among others, of the most useful schools in which to train for future responsibilities.

Finally, Mr. Tanner emphasised that the field of trade union interests and activities had widened considerably in recent years. The unions were now concerned with many questions from which they had been formerly excluded, but, nevertheless, the traditional function of safeguarding their members' interests remained supreme. They now had the much more difficult task of relating their interests to those of the nation in a situation which called for high qualities of leadership, loyalty and discipline. In such circumstances, Mr. Tanner suggested, the unions' task of promoting and safeguarding their members' interests and, in particular, the wages question, became more complicated and difficult. The A.E.U. was agreed upon the need for a new wage structure, but all must be prepared to give considerable study to any proposals which seemed to offer a more scientifically accurate basis for computing wages in relation to work, and which would be of benefit to the members of the union. As with other developments, however, more detailed study of and training in such new methods were required, but it was not sufficient to take refuge in a flat rejection of them.

Employment and Unemployment

The Ministry of Labour's latest report on the employment situation in Great Britain shows that in the month of April the total working population declined by 13,000 to 20,350,000. The decrease of 19,000 men in the working population was offset by an increase of 6000 women. During April there was an overall increase of 16,000 in the numbers employed in the basic industries, and the total engaged in those industries at the end of the month was 3,679,000. In the manufacturing industries, also, the number employed increased in April to 7,270,000, of which number 2,891,000 were engaged in the industries classified by the Ministry under "Metals and Engineering." Those employed in all the manufacturing industries on the production of goods for export numbered 1,996,000 at the end of April, compared with 1,992,000 in the preceding month.

In the four weeks ended May 12th, 380,000 people were placed in employment by Ministry of Labour exchanges. Of those placings, the Ministry of Labour states that 47,400 were in vacancies given first preference under the Control of Engagement Order. No directions were issued in April under the new arrangements introduced last October, but nineteen directions were issued to men normally employed in coal-mining and to three employed in agriculture.

The latest figures of unemployment relate to May 10th, on which date 290,006 insured persons were registered as out of work, compared with 300,840 on April 12th. This total included 219,452 men between eighteen and sixty-four. There were also 13,189 uninsured persons on the unemployment registers on May 10th.

French Engineering News

(From our French Correspondent)

The situation of the mechanical and electrical industries during two weeks in April has been given as follows: supplies of steel were fairly satisfactory except for sheet metal and wire, where delivery delays are still long. There is still a shortage of ball bearings and electric motors, and production of electric light bulbs has been reduced, due to lack of glass. There is also some difficulty in obtaining supplies of copper for electric cables. Coal and power supplies continue to be satisfactory. Transport by rail has improved, though road transport is hampered by lack of tyres and petrol. Labour, particularly in certain special classes, is lacking, and this is probably the most difficult question to be solved to ensure an immediate increase in production, which, nevertheless, is increasing slightly, due mainly to improved deliveries of steel products.

* * *

French constructed rolling stock received by the S.N.C.F. in 1947 included 18 steam locomotives, 20 electric locomotives, 7 railcars, and 28 trailers for rail-road use. German material received included 41 steam locomotives, 36 steam shunting locomotives and 86 tipping trucks. Foreign industry supplied 312 steam locomotives, 52,600 h.p. of diesel-electric locomotives and 25,015 covered and 8470 tipping trucks.

* * *

The Touring Club de France is awarding the Prix Edouard Lucas, worth 100,000 francs, for the winner of a competition for the first inventor succeeding in utilising atmospheric electricity for the traction of electric vehicles. This may be done either by utilising a vehicle or a fixed position, which will enable storage apparatus to be charged for use in propelling a vehicle. The vehicle must be able to run a minimum of 50km at a minimum speed of 25km an hour on a straight course and 5km an hour on a 7 per cent incline without being re-charged.

* * *

Whether Algeria can ever be an important producing country depends on the provision of an adequate water supply. The Colonisation and Hydraulic Service has started a new series of surveys on unexploited water resources. The Chott Ech Chergui is the largest and highest of the lakes of the High Plains, and the rocky terrain constitutes a practically closed basin. Results so far obtained confirm the idea of the existence of an important, exploitable water-bearing seam capable of irrigating 200,000 hectares and also capable of producing electrical energy of more than one milliard kWh annually. Provided present surveys continue rapidly, it is hoped that a plan for exploiting the water both for irrigation and production of electric power will be produced to enable the standard of local life to be improved.

* * *

By 1953 the wooden paving so characteristic of Paris streets will have completely been replaced by granite or asphalt. Work is proceeding at the rate of 10 miles a year and there are now only 50 miles left. The main objection to wood paving, explained Monsieur Georges Embry, Paris City Street Commission Engineer, is that it is slippery, unsuited to modern traffic, difficult to maintain, and has to be replaced every fifteen years. Shrinking also takes place during hot, dry weather, while if wooden paving gets too wet the paving swells. Poured asphalt is now being used for flat, shady stretches and paving of granite or porphyry blocks for the rest. This is considered better than concrete because the unstable soil of Paris would result in the formation of large cracks in a concrete road bed. Granite is also easier to take up for repairs to sewers, cables, and gas and water mains. On a slope, the block paving is laid with the "fan" formed by the blocks pointing downhill. With this arrangement, running water does not loosen the blocks and the tractive reaction of vehicles going up the hill compresses the blocks into the pattern. Likewise, block paving on one-way streets is laid with the "fan" pointing in the direction opposite to that of traffic flow.

Notes and Memoranda

Rail and Road

RAILWAY RECEIPTS.—Traffic receipts of British Railways in the four weeks ended May 16th amounted to £25,596,000, bringing the total for the first twenty weeks of this year to £123,832,000. London Transport's railway receipts in the four-week period ended May 16th were £1,129,000, making a total of £5,598,000 in the first twenty weeks of the year.

COKE WAGONS.—To cater for an increasing output of coke the Railway Executive is augmenting its existing stock of coke-carrying wagons by the conversion of 1000 mineral wagons. The addition of railed side and end extensions to the mineral wagons will give better loading capacity for this relatively light traffic and thereby reduce the total number of wagons required to carry the increased volume of coke.

LEVEL CROSSINGS.—In the course of a recent parliamentary reply, the Minister of Transport stated that on the British Railways system there were 22,600 occupation level crossings, nearly all of which were for agricultural purposes. Up to May 15th, twenty-one accidents, in which twelve people were killed and eleven injured, had occurred this year. The Minister said that safety problems at such crossings had been under consideration before the war, and he proposed to follow up the matter afresh in conjunction with the British Transport Commission.

BRITISH RAILWAYS' LONDON REPRESENTATIVES.—British Railways' service representation in the Greater London area has been reorganised and unified under new arrangements to be introduced on July 1st by the Railway Executive. This re-organisation eliminates the duplication of representation and will place at the disposal of the commercial interests of Greater London a railway representation service able to speak for the unified British Railways. Two headquarters have been established for the new railway service representation, those for passenger travel being at 14, Bishop's Bridge Road, Paddington, W.2; and for freight traffic, which includes parcels, at 13, Aldersgate Street, E.C.1.

Air and Water

WATER SUPPLY OF MALTA.—Replying recently to a question in Parliament, the Secretary of State for the Colonies, Mr. Creech Jones, said that following a comprehensive survey of the water resources of Malta plans for increasing the supply by an extension of the underground water galleries and by sinking bore-holes had been submitted and work on the necessary excavations had been begun. An increase of about 1,000,000 gallons in the daily intake of water had already been achieved, and it was hoped that on the completion of the improvement schemes a further increase of 1,000,000 gallons a day would be obtained.

NORTH ATLANTIC FLYING CONTROL.—Representatives of ten nations whose air lines fly across the North Atlantic Ocean have recently attended a meeting, convened by the International Civil Aviation Organisation, to arrange for the joint maintenance of such area traffic control and meteorological services in Iceland as are essential for the safety of international flight. The Icelandic Government has been maintaining these facilities, but has expressed its inability to continue to bear the expenditure involved, and an I.C.A.O. mission surveyed the situation early this year. It is suggested that the services to be operated under I.C.A.O. agreement should include the area control, approach control and aerodrome control stations at Keflavik airport, radio ranges and beacons, radio teletype circuits and meteorological observation and forecast offices.

Miscellanea

THE LATE MR. C. P. SUTTHERY.—We have noted with regret the death, on June 1st, of Mr. Colin Pellatt Sutthery, A.M.I.E.E., manager of the merchandise and lamp sales department of the British Thomson-Houston Export Company, Ltd. He was in his sixty-first year.

INDUSTRIAL RADIOLOGY.—The Industrial Radiology Group of the Institute of Physics will hold a summer meeting at 47, Belgrave Square, London, S.W.1, on Friday and Saturday, July 2nd and 3rd. The subject for discussion is "Acceptance Standards and the Interpretation of Radiographs." The meeting will begin at 10.30 a.m. and will continue until 5 p.m. on the Friday. The Saturday session will last from 10 a.m. to 12.30 p.m.

B.B.C. SCIENTIFIC ADVISORY COMMITTEE.—It is announced that a scientific advisory committee has been appointed to advise on the British Broadcasting Corporation's scientific research and its correlation with external activities in the same field. The chairman is Sir Edward Appleton, Secretary, Department of Scientific and Industrial Research; and the vice-chairman, Sir John Cockcroft, Director, Atomic Energy Research Establishment. Other members are Dr. H. G. Booker, Christ's College, Cambridge; Professor Willis Jackson, Imperial College of Science and Technology; Dr. R. L. Smith-Rose, Department of Scientific and Industrial Research; and Professor F. C. Williams, O.B.E., Electro-Technical Laboratory, Manchester University.

ELECTRIC POWER PLANT IN EUROPE.—A committee on electric power, set up by the United Nations Economic Commission for Europe, has recently concluded a meeting in Geneva. Among the matters which it considered was a tentative analysis of the demand and supply of power plant and equipment. On the basis of the somewhat limited information available, the committee found that for Europe as a whole, to implement her plans for power plant construction, the industries producing heavy power station and transmission equipment would have to achieve, during each of the next four years, outputs rather more than twice those of 1937. New construction programmes are so extensive that, if they are fulfilled, the demand for equipment for repair and maintenance alone is likely to exceed in 1950 the pre-war demand for both new construction and repair. The analysis foresaw particular difficulties for some importing countries, and suggested that the post-war situation indicated that new trade channels were called for. It suggested that the plans for new electric power plants could only be fulfilled if there were greatly increased exports from the United Kingdom and the U.S.A.

CHAMBER OF SHIPPING OF THE UNITED KINGDOM.—A number of important matters were discussed at the recent Council meeting. It was stated that revised arrangements for the issue of permits to build have been agreed with the Ministry of Transport, and that they had been accepted on the understanding that they were in the interests of British owners. It had been made clear, however, that the industry wished to see the removal of all restrictions of this character as soon as circumstances permitted. Discussions have taken place with the Ministry of Transport concerning the allocation of steel to the shipbuilding and ship repairing industries. Present conditions are, of course, imposed by the general shortage of steel, but every opportunity has been taken to impress on the Government the importance of giving shipbuilding and ship repairing a high degree of priority. It was reported that the first meeting had been held of the Fuel Committee set up in conjunction with the Liverpool Steam Ship Owners' Association under the chairmanship of Sir Guy Ropner, to deal with any questions affecting both coal and oil bunker supplies, including the grading of qualities of coal. Renewed representations have been made to the Ministry of Agriculture and Fisheries against the threatened expansion of Japanese whaling and the possibility of a resuscitation of German whaling.

GENERATION OF ELECTRICITY.—The official returns hitherto rendered to the Electricity Commission and now presented to the Ministry of Fuel and Power show that 3744 million units of electricity were generated by authorised undertakers in Great Britain during the month of April, 1948, as compared with the revised figure of 3387 million units in the corresponding month of 1947, representing an increase of 357 million units, or 10·5 per cent. During the first four months of 1948 the total number of units generated by authorised undertakers was 16,470 million units as compared with the revised figure of 15,722 million units for the corresponding period of 1947, representing an increase of 748 million units, or 4·8 per cent. The total number of units sent out from the generating stations of authorised undertakers during the month of April, 1948, i.e., units generated less units consumed in the stations by auxiliary plant and for lighting, &c., was 3532 million units, as compared with the revised figure of 3195 million units in the corresponding month of 1947, representing an increase of 337 million units, or 10·5 per cent. During the first four months of 1948 the total number of units sent out from the generating stations of authorised undertakers was 15,557 million units, as compared with the revised figure of 14,853 million units for the corresponding period of 1947, representing an increase of 704 million units, or 4·7 per cent.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Supervising Electrical Engineers

Monday, June 21st.—CENTRAL LONDON BRANCH: St. Ermins Hotel, Caxton Street, S.W.1. "The Sales Engineer in Industry," A. N. D. Kerr. 6.30 p.m.

Belfast Association of Engineers

Wednesday, June 23rd.—Visit to Belfast Airport, Nutt's Corner, Crumlin. 7 p.m.

Derby Society of Engineers

Wednesday, June 23rd.—Visit to Carriage and Wagon Works, London Road, Derby. 2 p.m.

Incorporated Plant Engineers

Monday, June 28th.—LEEDS BRANCH: Mines Department, The University, Leeds. "Ball and Roller Bearings," J. L. Potts. 7.30 p.m.

Institution of Electrical Engineers

Tuesday, June 22nd.—Science Museum, Exhibition Road, South Kensington, S.W.7. Conversazione 8–11 p.m.

Institution of Heating and Ventilating Engineers

Monday, Tuesday and Wednesday, June 21st, 22nd and 23rd.—Burlington Hotel, Boscombe, Bournemouth. Summer meeting.

Iron and Steel Institute

Tuesday, June 22nd.—4, Grosvenor Gardens, London, S.W.1. Iron and Steel Engineers' Group meeting. 10.30 a.m.

North-Western Fuel Luncheon Club

Wednesday, June 23rd.—The Engineers' Club, Albert Square, Manchester. "Whither Bound," The Rt. Hon. Sir John Anderson. 12 noon.

Catalogues

W. J. MEDDINGS, Ltd., Kingsley Works, Ipswich Road, Slough. Leaflet describing jig-sawing machine, sandstone grinding machine and mitre saw.

LOCKHEED HYDRAULIC BRAKE COMPANY, Ltd., Tachbrook Road, Leamington Spa. Service manual for Lockheed hydraulic servo-braking systems.

HADFIELDS, Ltd., East Hecla Works, Sheffield. Publication entitled "Billets, Bars and Slabs for Automobile and General Engineering Purposes."

SIEMENS ELECTRIC LAMPS AND SUPPLIES, Ltd., 38 and 39, Upper Thames Street, E.C.4. Catalogue No. 987 "Sieray" fluorescent lamps and equipment.

HUGGS MOTORS, Ltd., Witton, Birmingham, 6. Booklet entitled "Hints on the Installation and Maintenance of Electric Motors and Generators." Price 1s.

NORTHERN ALUMINIUM COMPANY, Ltd., Banbury, Oxfordshire. Booklet entitled "Specifications for Aluminium and Aluminium Alloy Products."

JAMES HOWDEN AND CO., Ltd., 195, Scotland Street, Glasgow, C.5. Illustrated booklet describing the Vortex system for removal of soot from tunnel gases.

BELLISS AND MORCOM, Ltd., Ledsam Street Works, Birmingham, 16. Pamphlet entitled "Fuel Economy," dealing with steam engines and steam turbines.

SOAG MACHINE TOOLS, Ltd., Juxon Street, Lambeth, S.E.11. Folder showing the range of Gilly horizontal borers, floor and table types, up to 6¼in capacity.

Contracts

THE ISMAILIA VALVE COMPANY, 17, Victoria Street, Westminster, S.W.1, has received an order for ninety-five tank discharge valves for new steel water tanks for the South African Government Railways, which are being built by Braithwaite and Co., Structural, Ltd.

SIMON-CARVES, Ltd., Cheadle Heath, Stockport, has received an order from the Helsinki Corporation gasworks for coke ovens, gas producer plant and ancillary equipment worth over £650,000, to provide gas for the city and to replace the present plant. More than £420,000 of this sum will be expended on entirely British materials and services. The contract includes a battery of twenty-two Entire Underjet coke ovens to carbonise 300 tons of coal per day, and mechanical gas producer plant. Coal and coke-handling plant is also included in the contract, which, it is hoped, will be completed in time for the winter load of 1951–52.

THE F.P.A. JOURNAL.—The Fire Protection Association has sent us a copy of the first issue of its quarterly journal. This publication, it is stated, is to be circulated to all members of the Association with the object of keeping them informed of the latest developments and trends in fire protection and prevention.

Personal and Business

DR. W. G. HISCOCK has been appointed a director of Imperial Smelting Corporation, Ltd.

MR. R. G. BRANDON has been appointed general sales manager, lamp and lighting department, of the British Thomson-Houston Company, Ltd.

BARLOW-WHITNEY, Ltd., has formed a subsidiary company under the title Barlow-Whitney South Africa (Pty.), Ltd., at P.O. Box 313, Johannesburg.

THE HOFFMANN MANUFACTURING COMPANY, Ltd., has opened a new branch at 18, Tempest Hey, Liverpool (telephone, Central 3595; telegrams, "Mannhof, Liverpool").

MR. G. M. P. MCKELLEN has been appointed Secretary of the Manchester Association of Engineers. From July 1st the Association's address will be 20, Booth Street, Manchester, 2 (telephone, Central 2796).

PATERSON HUGHES ENGINEERING COMPANY, Ltd., states that its Midland branch office is now situated at 30, Horse Fair, Birmingham. Mr. J. Ford, formerly chief engineer, London, has been appointed manager of the Midland branch, and Mr. L. R. Kemp is chief sales engineer.

CROMPTON PARKINSON, Ltd., states that Mr. R. T. Pardoe, sales manager for switchgear and transformers, is now responsible also for the sales management of its instruments and meters. Other appointments announced by Crompton Parkinson, Ltd., are:—Mr. J. Y. Daniel, assistant works director (South); Mr. J. B. Scott, general sales manager, plant division; Mr. K. Younger, London plant branch manager; and Mr. F. A. Langham, machine sales manager.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of report	Title	Post free s.	d.
B.I.O.S.:			
1670	The Production of Ship Armour in Italy	22	10
1678	The Rolling of Broad Flanged Beams in Germany	4	8
1696	German Magnetic Separator Applications, particularly the Concentration of Minerals Feebly Magnetic	2	7
1711	German Tungsten Carbide Wire, Bar and Tube, Drawing Dies (with brief reference to other Cemented Carbide Products) ...	9	3
1727	The Manufacture of Tungsten Carbide and its Application to the Coal Mining Industry ...	2	7
F.I.A.T.:			
631	Adler Werke, Frankfurt: Magdeburg Vertical Centre Column Hydraulic Multi-Spindle Automatic Chucking Machine	10	2
B.I.O.S.:			
1033	Oilfields Investigation, Italy ...	12	3
1541	German Metal-Spraying Techniques	8	2
1657	German Motor Control Gear ...	14	3
1701	Pharmaceuticals: Tabletting, Ampouling and Packing in Selected German Factories ...	25	4
F.I.A.T.:			
291	Gas Turbine Project for a Schnell Boat Developed by Blohm and Voss, Hamburg	1	1
889 (Supplement)	Urea Manufacture at the I.G. Farbenindustrie Plant, Oppau	1	1
921	Manufacture and Purification of Arc Acetylene	13	3
978	English Translation: The Synthesis of Acrylamides and the Co-polymerisation of Acrylamides and Butadiene	1	7
984 (Supplement No. 1)	Manufacture of Phthalic Anhydride by I.G. Farbenindustrie	1	7
1098	Etch and Percussion Figures, and Twinning of Quartz	7	8
1113	The German Synthetic Sausage Casings Industry	2	7
1124	Circular Grit Chambers (Sewage Disposal Plant)	3	1
1307	Manufacture of Oxalic Acid ...	1	7
1308	Process for the Manufacture of Beta-Oxynaphthoic Acid, Sodium Salt	1	7
1309	The Manufacture of Heliogen Blue B and Phthalodinitrile at I.G. Farbenindustrie Plant at Ludwigshaven	2	1
T/B T–18 ...	Hydrogen Cyanide Synthesis from Methane and Ammonia ...		3
T/B T–25 ...	Beryllium Nickel Alloys		3
T/B T–31 ...	"Immergan A" for Preparation of Chamois Skins		3
T/B T–40 ...	Processing Bavarian Clay to Activated Clay (Bleaching Clay)		3
T/B T–45 ...	Drawing Ink Manufacture at the Gunther-Wagner Plant in Hanover		3
T/B T–46 ...	The P3 Cleaners: Henkel and Cie, Dusseldorf		3
T/B T–48 ...	Preparation and Forming of Ceramic Materials		3
C.I.O.S. XXXIII-10	German Research and Development in Tank Armour Welding	6	2
B.I.O.S. 394	Technical Report on the Ruhr Coalfield, Volume III, Appendix No. 30: Production Statistics for Mines in Flat, Medium and Steep Formations.—This report has been published separately by His Majesty's Stationery Office as a Ministry of Fuel and Power publication and should be ordered by title ...	1	8
1648	Manufacture of Air Compressors and Pneumatic Tools and Appliances in Germany	12	3
1689	German Fine Balance Industry...	2	1
1705	The German Ceramic Industry ...	25	3
1722	Additional Information concerning the Fischer-Tropsch process and its Products...	20	5
1724	German Papermaking Industry, with particular reference to Paper Mills using Rags as Raw Material and producing Filter Papers, Blottings and Fine Papers	7	2
1733	Interrogation of Dr. Hampel on his Design for a Suspended Centrifugal Collector for Rayon Spinning	2	1
1736	Interrogation of Dr. Engelhardt, Research Chemist of I.G. Farbenindustrie, on the Production of Synthetic Waxes, Nibren and Clophen (Chlorinated Naphthalene and Chlorinated Diphenyl)	2	1
Misc. 68 ...	Problems of Dephenolisation of Waste Liquors	3	8
JAP/PR/1717	Sericulture in Japan	5	8
JAP/PR/1718	Tungsten Resources of Japan ...	3	2
F.I.A.T. T/B T–53 ...	Iodine Substitutes	0	3
B.I.O.S. Misc. 69 ...	German Motor Vehicles Industry Report	6	2
Misc. 70 ...	Manufacture of Porous Stones used in Walter Hydrogen Peroxide Catalyst (M.P. 14)	1	1
Misc. 71 ...	German Diesel Fuels	3	2
Misc. 73 ...	Fire-proofing Agents in the Textile Industry	1	1
Misc. 74 ...	Manufacture of Spun Rayon Yarn	1	1
JAP/PR/264	Acceleration (G. Forces): Research Equipment, Studies, Results and Training...	12	9
394	Technical Report on the Ruhr Coalfield, Volume III, Appendix No. 1: Problems of Increasing Coal Output	1	1
1370	Viscose manufacture with Special Reference to the Accelerated Ageing of Alkali-Cellulose. Interrogations of Dr. Lakatos...	1	7
1410	Production of Titanium Oxide at Aussig: Interrogation of Herr Walter Neumann	1	1
1544	The German Crane Industry ...	4	2
1587	Drying and Filtration in the German Chemical Industry ...	20	4
1656	Extrusion of Light Alloys at I.G. Farbenindustrie, Bitterfeld: Interrogation of Herr K. F. Brauninger	10	3
1672	Thermal Measuring Instruments: Thermostats and Associated Apparatus	6	2
737	Continuous Chlorination of Benzene Process at I.G. Farbenindustrie, Bitterfeld and Wolfen, for Manufacture of Paradichlor Benzene as Primary Product: Interrogation of Dr. Richard Klar	1	1
1739	German Welding Gauges	2	1
1742	Sodium Perborate and Hydrogen Peroxide at Falkenau, Czechoslovakia: Interrogation of Herr Watler Neumann	1	1
F.I.A.T. 813	Photo-Reproduction Research of Kalle and Co., A.G.: Index of Micro-Filmed Reports	3	8
1175	A New Frequency Modulated Radio Sonde: Report in German	1	7

Technical Information and Documents Unit, German Division, Board of Trade, 40, Cadogan Square, S.W.1, which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

A Seven-Day Journal

British Internal Combustion Research Association

On Wednesday, June 16th, the British Internal Combustion Engine Research Association held a celebration luncheon at Claridge's Hotel, London, to mark the fifth anniversary of the Association's inaugural meeting. Over eighty members and guests were present. The chair was taken by Viscount Falmouth, the President, and the principal guest was Mr. G. R. Strauss, the Minister of Supply. In proposing the toast of B.I.C.R.A., Mr. Strauss made reference to the remarkable development of the internal combustion engine, during the last half-century. Britain in particular had, he said, achieved a high place in the design of small air-cooled engines, horizontal gas and oil engines, and the dual-fuel engine. It was very satisfactory, he remarked, that over 90 per cent of the engines produced in this country were exported. Research such as the Association was carrying out would continue to be warmly supported by the Government. In his reply, Lord Falmouth spoke of the beginnings of the Association and its close collaboration with the Department of Scientific and Industrial Research. It was fortunate, he said, in its Director of Research, Engineer Rear-Admiral D. J. Hoare, under whose leadership an important programme was being carried out at the Slough Laboratories and at universities. That programme included such subjects as torsional vibration, pressure charging, and a survey of future developments. The toast of "The Guests" was ably proposed by Mr. O. Evans, the Chairman of the Research Council, who referred to the very cordial relations existing between the Association, the D.S.I.R. and other research associations. Sir Edward Appleton, the Secretary of the Department of Scientific and Industrial Research, responded. He said that engine research had contributed much to our knowledge of engine noise and the cast irons used in engine construction. It was the intention of the D.S.I.R. to call a joint meeting of the various research associations, so that common problems could be reviewed and the value of research from the industrial and national points of view still further increased.

Scientific Information Conference

The Conference on Scientific Information, which has been arranged by the Royal Society, opened on Monday last in the hall of the Royal Institution, Albemarle Street, London. Sir Robert Robinson, President of the Royal Society, was in the chair, and in welcoming the 500 delegates, explained that the conference was the outcome of requests made at the Royal Society Empire Scientific Conference and the British Commonwealth Scientific Conference in 1946. Sir Robert said that scientific knowledge was the collection of facts gleaned in the organised search for truth, and it was vital to the scientist that that knowledge should be quickly and freely accessible to him wherever he might be. The purpose of the conference is to discuss and recommend to the Royal Society ways in which the present systems of publishing original scientific work, abstracting it and indexing it for future reference can be improved. Sir Edward Appleton, F.R.S., Secretary of the Department of Scientific and Industrial Research, also spoke at the opening ceremony and pointed out that no scientist gave of his best in isolation. In spite of everything done to foster the movement of scientists and to effect personal contacts between them, it had to be admitted that they lived chiefly on the printed word. Sir Edward thought that often it was by the medium of publication that a scientific worker might be helped—and indeed inspired—by a fellow worker whom he might never have seen and who lived thousands of miles away. The conference will continue until July 2nd, and many of its duties have been assigned to "working parties" formed from its membership. These working parties will present their reports to a series of plenary sessions beginning on Tuesday next. An exhibition illustrating some aspects of scientific information services is being held during the conference at the Royal Society's Rooms, Burlington House, Piccadilly, W.1. It includes recently developed mechanical indexes, micro-photographic methods of document reproduction, and dyeline copying equipment.

The Launch of H.M.S. "Bulwark"

At 12.30 p.m. on Tuesday, June 22nd, the Light Fleet Aircraft Carrier H.M.S. "Bulwark" was launched from the Musgrave Yard of Harland and Wolff, Ltd., Belfast. The naming ceremony was gracefully performed by the Countess of Granville, the wife of Earl Granville, the Governor of Northern Ireland. At the luncheon which followed the Countess was presented with an old Scottish silver rose bowl, made in Edinburgh in 1785. The toast of "The Ship" was proposed by Sir Basil Brooke, Bart., the Prime Minister of Northern Ireland, and Admiral Sir Frederick Dalrymple-Hamilton, the Flag Officer Commanding the Coasts of Scotland and Northern Ireland, responded. The toast of "The Builders" was proposed by Vice-Admiral R. H. Portal, and the chairman, Sir Frederick E. Rebbeck, replied. Sir Frederick made reference to the fact that the "Bulwark," laid down in 1944 and just launched, was the last of a long series of aircraft carriers in the construction of which his firm had specialised. H.M.S. "Bulwark" is a sister ship to the "Hermes" class of light Fleet carriers, "Albion" and "Centaur," which were designed during the war for working with the Fleet on offensive operations. They have a displacement of about 18,000 tons, and an extreme length of 736ft, a length between perpendiculars of 650ft, and a breadth on the waterline of 90ft, with increased width over the sponsons. Electric welding has been extensively used in the construction of the hull. The propelling machinery has been made at the Queen's Island works, and it comprises a twin-screw arrangement of Parsons geared turbines taking steam from oil-fired, three-drum Admiralty pattern boilers. It is believed that the speed of the ship will approach about 30 knots. In the course of her construction the "Bulwark" has been modernised in order to bring the design completely up to date. The electrical machinery will include both turbine and oil engine-driven generating plants, and, in order to serve all the electrically driven machinery, more than 250 miles of electric cable will be worked into the ship.

The Passenger and Cargo Steamer "Commandant Quere"

On Thursday, June 17th, we were invited by John I. Thornycroft and Co., Ltd., and the Compagnie Générale Transatlantique, to inspect at Southampton the steamship "Commandant Queré," which is the first liner to be built in Great Britain for the French Merchant Navy. After having carried out successful trials, the ship left the Solent on Thursday evening for Le Havre, where she embarked passengers for a cruise to North Africa, Gibraltar and Marseilles. On arrival she will take up the mail and passenger service between Marseilles and Corsica. She has a length of 363ft with a breadth moulded of 50ft, and a height to the upper deck of 28ft. There are five decks, and three cargo holds, and provision for carrying motor cars in the 'tween deck spaces. Excellent accommodation for tourist, third and fourth-class passengers is provided. The propelling machinery comprises a twin-screw arrangement of Parsons geared turbines, designed for a maximum power of 5400 s.h.p. at a propeller speed of 210 r.p.m. Steam is furnished by two Thornycroft watertube, oil-fired, three-drum boilers of the latest pattern, with Thornycroft oil-burning equipment. The ship was, we noted, remarkably free from vibration when running ahead or astern. The designed speed of 18 knots was surpassed with a trial speed of 18·63 knots. Particular interest was shown in the new type of streamlined funnel-top, which in a strong westerly wind showed that the smoke was carried well clear of the after decks. In a later issue we propose to give some further particulars of this interesting vessel.

The World Power Conference

A two-day meeting of the International Executive Council of the World Power Conference was held in Stockholm recently, and was attended by representatives of nineteen countries. Among the British delegates was Sir Harold Hartley, chairman of the International Executive Council, and of the British National Committee. It was announced that the building of the Institution of Civil Engineers is to be the headquarters for the Fourth Plenary World Power Conference, which will be held in July, 1950, and approval was given by the council to a recommendation that the theme of the conference should be "World Energy Resources and the Production of Power." The council also discussed the future activities of the World Power Conference and received tentative invitations from India for a sectional meeting to be held in 1951, concurrently with the Fourth Congress of the International Commission on Large Dams, and from Italy and Switzerland for an "Alpine" sectional meeting in 1952 or 1953. The Hungarian delegates suggested a "Danubian" sectional meeting, which, it was proposed, should be organised jointly by the National Committees of the Danubian countries on a regional basis. Following a request from the Economic and Social Council of the United Nations, consideration was also given to the fuel and power sections of the provisional programme of the United Nations Scientific Conference on the Conservation and Utilisation of Resources, which is to be held in the U.S.A. in May, 1949.

Ministry of Fuel and Power Appointments

The Minister of Fuel and Power has appointed Dr. H. Roxbee Cox, M.I.Mech.E., F.R.Ae.S., who is at present director of the National Gas Turbine Establishment, to be Chief Scientist at the Ministry of Fuel and Power. Sir Alfred Egerton, F.R.S., Professor of Chemical Technology at the Imperial College of Science, and Secretary of the Royal Society, has accepted an invitation to become chairman of the Scientific Advisory Council, which is to be set up to advise the Minister of Fuel and Power on the scientific aspect of his statutory duties. Under the Nationalisation Acts, the boards of nationalised industries become responsible for research in their respective spheres, with the proviso that they should act on lines settled from time to time with the approval of the appropriate Minister. It is explained that when the gas industry has been brought under national ownership, there will be a need for general co-ordination of research in the fuel and power field. and it has been decided that the Ministry of Fuel and Power should assume responsibility for this co-ordination. It is therefore expected that one of Dr. Roxbee Cox's first tasks will be to survey the research at present being conducted in the field of fuel and power and to see whether there is any ground not being covered. Dr. Roxbee Cox will also study and advise upon the problems arising from the application of existing scientific knowledge and from the need to secure the best use of the country's fuel and power resources as a whole. The proposed Scientific Advisory Council for the Ministry of Fuel and Power will be a part-time body, with which Dr. Roxbee Cox will work in close conjunction. He will also supervise the work of the existing Fuel Efficiency Branch of the Ministry.

A Transatlantic Train Service Comparison

By EDWARD H. LIVESAY

No. II—(*Continued from page 587, June 18th*)

PROBABLY some readers who were sufficiently interested in this essay to analyse Part I will have already guessed what type of locomotive "built on familiar lines," and capable of meeting the heavy demands pictured therein, was foreshadowed—it is the "Beyer-Garratt" (Fig. 5). No other type with which I am acquainted has the proven ability to do the work that it was assumed might be necessary in the future—that is, the hauling of 600-ton trains from London to the North at an average inclusive speed of 60 m.p.h. or better, making half a dozen stops *en route*. If there is another type that could do this I should be interested to hear about it! The "Garratt" satisfies all the factors in the problem, and, in addition, other prerequisites that so hamper the British designer of powerful "basic" types, difficulties that his transatlantic confrère is more or less free from—the cramped loading gauge, axle-loading restrictions, permanent way and bridge limitations, and so on—difficulties that prevent the present fine British "Pacifics" ever developing substantially beyond the stage they have now reached, if this should be required. No alteration to existing equipment, constructional and civil engineering features would be called for—except, perhaps, one, which is more a matter connected with the length of the trains the "Garratt" is able to handle than the engine itself, and will be touched upon later. Turntables would be no embarrassment—the "Garratt" ignores them. It would fit in with things as they are, being peculiarly adaptable.

The expression "proven ability" has been used above; this referred to the fact that existing "Garratts" have been doing heavy express work for years with evident safety and satisfaction in various parts of the world; but it pointed more particularly to the performances of one of the more outstanding examples of the design that has so far appeared; one specifically built for fast travel with heavy loads over a difficult route. These engines are the 4-6-2+2-6-4 express "Garratts" built in 1932 and subsequently for the Algerian Railway, undergoing extensive and thorough trials in France before taking up their duties in Africa, from which they emerged with great credit. These are powerful locomotives—even more so than the visionary engine with which this thesis is concerned—having cylinders (four), 19½in by 26in, a tractive effort of 65,849 lb, and a weight of 216 tons. But in one respect I think the actual and fanciful engines differ; the Algerians are apparently not intended to do non-stop runs of, say, 100 or more miles at high speed, because, though provided with a 58 square foot grate, no mechanical stoker finds a place upon them. I cannot believe that any fireman could maintain a full head of steam in such a large engine for long distances if it were going "all out," by the exercise of his unaided thews and sinews, especially in such a torrid climate as that of North Africa. Should he seriously attempt this, the impossible, I can imagine the tragi-comedy that would ensue in all its Gallic *abandon*. I picture the fireman, "full of strange oaths and bearded like the pard," indefatigably wielding his clanging shovel, only pausing in his efforts to glance fearfully at a steadily receding gauge-needle, or to turn a glistening brow towards the cool draught blowing down from the turbo-fan provided for this very purpose, but forced to realise sooner or later than he is waging a losing battle, which can have but one end. Man's inhumanity to man—let us turn away from this depressing picture! Beyond a peradventure, nothing like this would or could happen in the roomy cab of our projected British "Garratt." There, a worm conveyor, tirelessly turning, would bring the coal forward from the bunker right into the firebox, the fireman, cool and unhurried, meanwhile taking his ease on a "stuffed seat," occasionally varying the monotony by adjusting the feeder valves and looking out for signals that, due to track curvature or a generous boiler, are beyond the driver's ken. A pleasanter picture than the other, and but little exaggerated.

One or two other points may be mentioned about these Algerian "Garratts" and their relatives. The driving wheels are only of moderate diameter, 5ft 11in, yet during the above-mentioned tests speeds of over 80 m.p.h. were reached, and it was stated that higher figures might have been recorded without difficulty had not "blanket" restrictions—such as the limiting 75 m.p.h. usual on French railways—forbade, and this there is no reason to doubt. The long and exceptionally flexible wheelbase, coupled with the good feature that there is "nothing in the middle," the even weight distribution; these are factors that in themselves make the "Garratt" design inherently suitable for high-speed running. In the Argentine, too, "Garratts" have been doing real express work for many years with perfect satisfaction. But there is no need to gild the lily in this matter of speed capacity; it is sufficiently proven. Granted that this type of articulated locomotive was originally intended for moderate speed freight work over lightly built track and round severe curvature, it soon became evident that it was equally well suited to more ambitious tasks on a much larger scale. It steadily developed from the first timid experiment on the Tasmanian Railway in 1909 with a four-cylinder, compound 0-4+4-0 weighing 33 tons, through a constantly expanding catalogue of types of increasing size and power, culminating in the Algerian machines and an impressive 4-8-2+2-8-4 freight engine weighing upwards of 240 tons for Russia. I have often wondered what happened to this fine engine, but *voilà*!—it is behind the iron curtain! Numerous other almost equally striking "Garratts" operate in India, Burma, Africa—particularly South Africa and Rhodesia—and South America. The history and development of the "Beyer-Garratt" is indeed very interesting; somebody really should write it.

Returning to the "suggested" engine, it should be made clear that the design outlined (Fig. 5) is entirely the writer's; Messrs. Beyer-Peacock have not been consulted. I do not think, however, that it clashes very seriously with the company's predilections, based as these are on their great experience; the writer naturally has not had the advantage of drawing upon them. I trust my outline, at any rate, will have their qualified approval—provided it is not too qualified! It is admitted, too, that none of the dimensions is to be regarded as a law of the Medes and Persians; they are all tentative approximations, which are thought to come near enough to the reasonable and possible. An engine built roughly to these measurements should be capable of doing the work foreshadowed, could be run over existing British lines, and does not offend accepted British canons. The chief figures are as follows:—

Cylinders (four)	18½in × 28in
Driving wheels, diameter	6ft 6in
Boiler:	
Diameter, outside	7ft
Length between tube plates	18ft
Height to centre line	9ft
Heating surface:	
Superheater	1,250 sq. ft.
Tubes and flues	2,900 sq. ft.
Firebox and siphons (two)	400 sq. ft.
Total	4,550 sq. ft.
Firebox	Belpaire
Fire-grate area	65 sq. ft.
Pressure	300 lb
Tractive effort at 85 per cent b.p.	60,974 lb
Factor of adhesion (full supplies)	4·8
Weight:	
On drivers, per pair	22·5 tons
On drivers, total	135·0 tons
Each unit, maximum (full supplies)	125·0 tons
Total, maximum (full supplies)	250·0 tons
Wheelbase:	
Unit	34ft 6in
Total	95ft
Water (pick-up apparatus)	6000 galls.
Coal (mechanical stoker)	15 tons
Width overall	9ft
Height, maximum	13ft 3in

Though perhaps a little dangerous, some explanation may be ventured for certain of these figures. As no speed much over 90 m.p.h. is proposed, or would be necessary as a rule, 6ft 6in driving wheels should be large enough. The chief feature of the services forecasted would be consistently high, but not superhigh speeds with heavy loads, maintained uphill, down-dale and on the level; spectacular dashes at 110 m.p.h. to recover time lost on rising gradients form no part of the picture. Most of the running would be done at 75–85 m.p.h., and hence the 6ft 6in wheels.

The 18ft tubes are somewhat longer than usual with "Garratts"; this is to provide adequate heating surface without packing the boiler with small-diameter tubes, and to avoid the risk of incomplete combustion—in the absence of a combustion chamber—before the gases reach the smoke-box, particularly when the engine is working hard, as this proposed machine generally would be. To the writer there always seems to be something lacking in a 12ft to 15ft boiler; could this be a few feet of tube length? Besides, a large boiler is a fine heat reservoir. (These imputations are advanced with humility; if they are quarrelled with seriously, my head may become bloody, but will remain unbowed.) In this connection, memory holds the door of two through runs made with the "International Limited" from Montreal to Toronto in the cabs of C.N.R. 6ft 8in "Hudsons," already mentioned and described (THE ENGINEER, December 5, 1941). The engines were thrashed mercilessly most of the time; their chimneys were harshly roaring volcanoes of sound and fury, to reach which the products of combustion passed through a 31in combustion chamber and 19ft 1in of tube length. Had there been no combustion chamber at all, and several feet less of tube, I can imagine serious waste of fuel, heat loss, and unburnt gases forced from the vomiting stacks. And such, I opine, would be the case on any short-boilered engine habitually "caned."

Two siphons are suggested, valuable adjuncts to firebox and boiler efficiency,

increasing the heating surface where every square foot tells most, and improving circulation where it is most likely to be bad. The siphon is almost universal in North America; its worth has long been accepted there as proved. The 65 square foot grate should be ample in conjunction with four 18½in cylinders when fed by a mechanical stoker; it should be of the rocking type.

It is hardly necessary to admit that the weights have not been worked out with meticulous accuracy, but the corresponding figures of several of the larger types of "Garratts" were studied and used as yardsticks; the empirical results are probably near the mark. Provided the total weight fell within the 250-ton limit settled on, as would almost certainly be the case, British rail and bridge-loading standards would not be exceeded. Fifteen tons of coal should be sufficient to take a 600-ton train at high speed from London to Edinburgh or Glasgow, allowing 80 lb per mile, a substantial figure which very likely would be reached. But there—one cannot make omelettes without breaking eggs—very little of those 15 tons might be left when the "Garratt" came to a stand in Waverley. But consider what would have been done—a 600-ton train brought 392 miles in 392 min., including stops at Grantham, York, Darlington, Newcastle and Berwick. Well worth 15 tons of coal, surely! (If insufficient, a ton or two might have to be taken on *en route*, say, at York, from an up-to-date quick-coaling plant that could put it aboard in three or four minutes, or even less, as I have seen done several times with the "International Limited," or make the bunker bigger.)

The lengthy wheel base would make existing turntables useless, so the engine would necessarily have to run either end leading, which is simple enough with the "Garratt" type. It follows that the principal controls—regulator, reverse, brake valves, whistle and sanding gear—must needs be duplicated, on opposite sides of the cab, but there would be no difficulty about this—the Algerian engines, for example, are so equipped. For fast running the driver should certainly sit on the proper (left) side of the cab with all his gear conveniently at hand, both for signal and platform observation. I have ridden on several classes of engine in Britain fitted for right-hand operation, and could not help thinking and noticing how inconvenient, if no worse, the system was. The outward journey from Cricklewood to Toton of my L.M.S.R. "Beyer-Garratt" runs (THE ENGINEER, October 3, 1941) was made bunker-first, which meant that not only did the driver sit on the wrong (right—excuse the Hibernianism) side, but insult was added to injury by most of the controls being behind him! The twisting round that this Alice-through-the-looking-glass arrangement entailed might easily have resulted in his getting wryneck; watching him certainly gave me a pain in mine! However, the speed of the coal trains the engines were pulling was so low* that this right-wrong-back-the-front position was just bearable, but though it may be palliated under these conditions it would be indefensible on an express engine.

Returning to the suggested engine, the tank sides of both front and back units might be pinched in along the upper part to give the driver a wider angle of vision and better "look-ahead"; chimney, dome and safety valves should be contained in a smooth casing right up to the cab, to encourage the flow of the exhaust along the top of the boiler and over the roof, and side plates should be fitted near the rear of the front unit and beside the double chimney with the same end in view; long cowls would be useful over the front windows. Presumably the engine would be vacuum fitted, somewhat of a pity in one respect, Westinghouse apparatus providing a convenient supply of compressed air to operate reverse, water scoop, window wipers, and so on, things that no longer should be manually worked on an up-to-date locomotive. On the Algerian engines the reverse is electrically traversed by power from a separate turbo-generator, a somewhat complicated but evidently practical arrangement. If this plan is by-passed, steam could be used, common practice as long ago as the Stirling era, and still the method employed in some quarters. Vacuum gear could be devised to work the scoop and wipers, and, of course, the engine would be electrically lighted throughout. Lastly, roller bearings for axles and major points of the motion would form part of the make-up of this well-equipped locomotive, the design of which is nothing if not up to date, in fact futuristic! At any rate, it is practical and in no way freakish; its general lines are well proven. This is more than can be said of some locomotive flights-of-fancy almost worthy of Heath Robinson that were described in THE ENGINEER under the title "Some Noteworthy Locomotives," an article which I have in my archives, and which is dated February, 1897. In it were outlined a number of remarkable locomotives, actual and visionary, the former including the fascinating but ill-fated "James Toleman," a four-cylinder, simple 2–A–A† with an oval boiler (a throw-back to Vulcan Foundry practice of 1848 actually), designed by one F. C. Winby, built by Hawthorn, Leslie, and sent to the 1893 Chicago Exhibition. Its impressive size and multi-cylinder originality fascinated me in my very youthful days, and for many years I treasured the sectional drawings of it that were published in *Engineering*, but it was a failure, chiefly due to boiler and firebox defects that could have been remedied—at the expense of a new boiler!—and after some desultory running on American rails was abandoned and left to rust away on a Milwaukee siding. A sad end to a costly and hopeful experiment. Among the purely visionary designs given a place in this article was an impressive 3–1–A† exaggerated "Crampton" with a pair of 12ft driving wheels and a "Flaman" boiler (double-barrelled, superimposed, the upper drum containing steam and the lower one water and tubes). The name of the designer did not transpire, but he was certainly ambitious. Another extravagant affair was suggested by Michael Reynolds, of all people—he should have known better—a 2–1–A† boasting a pair of 10ft drivers in front of the firebox, but no steadying trailers behind it—the engine would have nosed furiously. The driver's cab was in front of the smoke-box, the fireman carrying on at the other end, and the whole machine was boxed in and windowed like a conservatory. This bygone article is mentioned because it lends confirmation to the maxim "there's nothing new under the sun"—another that should not be taken literally—as evidently I am not the first to have an ideal locomotive-of-the-future and betray himself in the pages of THE ENGINEER.

The anticipated advantages of the projected "Garratt" have been enlarged upon; what of the drawbacks? No doubt they would exist, but possibly it would be simplest to let readers point them out‡, partiality towards my own creation naturally leading to personal prejudice in its favour. Cost? Half as much again over that of the present "Pacifics" most likely, but as the engine would be in similar ratio more powerful this could scarcely be counted a "drawback"—power has to be paid for. Com-

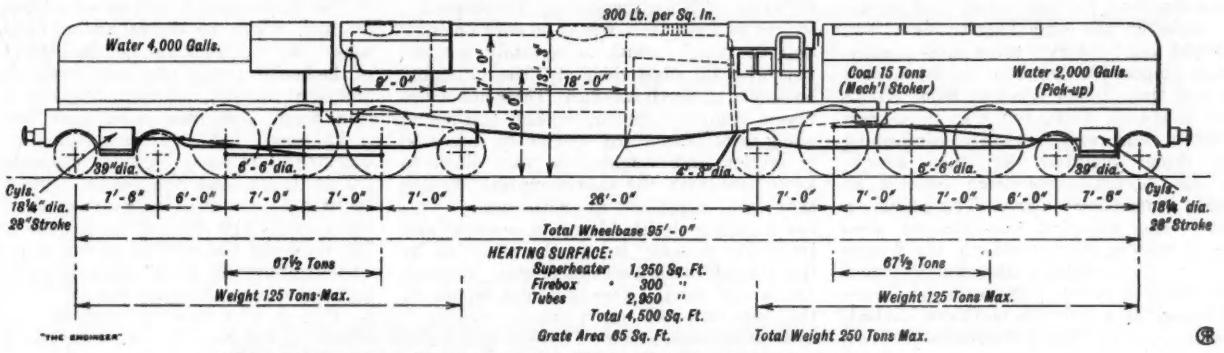


FIG. 5—SUGGESTED BEYER-GARRATT TYPE EXPRESS LOCOMOTIVE

* I cannot resist at long last, the war being over, and "giving information to the enemy" no longer a crime deserving "something lingering with boiling oil in it," openly stating what was rather glossed over in the account of these runs for the above reason—that due to the black-out, the tremendous flow of coal to London and what have you, the Cricklewood-Toton runs produced an all-time speed record for my numerous footplate trips, before or since—low speed, that is. The last 10 miles, from Loughborough to Toton, were covered in 3 h. and utter misery—average, 3·3 m.p.h. Lord Haw Haw would certainly have made a song about this had he known it; it would have given both information and comfort to the enemy.—E.H.L.

† There are obvious advantages in the German system of wheel notation over the usual British arrangement when dealing with out-of-the-ordinary locomotives such as these; "2–A–A" really tells you something—"4–2–2" either misleads you, or leaves you quite in the dark. Similarly, with "3–1–A" and "2–1–A" you know what the locomotives are, whereas "6–2–2" and "4–2–2" are almost meaningless, and do not enable the engines to be pictured.—E.H.L.

‡ I have a suspicion that some readers will do so without waiting for permission! Nevertheless, this is freely granted, in the pleasant anticipation that it will be in complete harmony with the Voltairean tradition: "I disagree with every word you say, but I will defend with my life your right to say it!"—E.H.L.

plication? Not really serious, chiefly taking the shape of duplication of running gear and motion; as it were, two locomotives in one, with only one boiler, always the most costly and troublesome part of the machine. The crew would work no harder than on the present types; the fireman actually much less so, thanks to stoker firing. There would, however, be one rather serious difficulty to get round, referred to in the opening paragraph of this Part II—the difficulty, if not impossibility, of accommodating the lengthy trains this "Garratt" would handle alongside some of the existing platforms. The three London termini, King's Cross, St. Pancras and Euston would all be sinners in this respect, and I can only hazard the view that it does seem rather a counsel of imperfection if this alone prevented the running of trains best suited to conditions over the rest of the systems because the platforms of three stations, however important, did not correspond with requirements. Lengthen the platforms, or, if this positively cannot be done for reasons of real estate, then make up the extra long trains at two platforms and "marry" them subsequently. Is this impossible or too inconvenient? The last time I left London, from King's Cross in March, 1940, I did so in a train of length and weight closely conforming with those pictured in this article, and the circumstances were exactly as detailed immediately above. The engine—a "V 2"—and the first two coaches were clear of the departure platform, the former nearly in the tunnel; the weight must have been well over the 600-ton mark, every seat being taken and the corridors jambed, the passenger list largely made up of Service personnel, and so things continued to Grantham, where I detrained for Sheffield. The "V 2" did exceedingly well with the heavy train, probably all that the schedule called for, which fell far short, naturally, of the figure that would be demanded of our projected "Garratt," which it could easily satisfy. The chief point about the latter would be its great reserve of power, which would be at call whenever needed to offset delays at stopping places and signals; even with a 600-ton train time could be made up and schedules regained. As to inadequate platform length at the London termini, 600-ton trains would not necessarily always start as such; they might be 500 tons there, picking up additional coaches farther down the line. Admittedly, all this would pose problems needing thought and solution, which I had better leave to other and more informed heads!

This concludes the essay on comparative railway services on the two sides of the Atlantic, outlining a suggested "Beyer-Garratt" express locomotive for probable future conditions on British railways. It seems feasible enough to me, and assuming that fewer and heavier, but equally fast, trains are likely to be the rule in the future, this engine, coal fired and orthodox, but exceptionally powerful, could handle them without difficulty. Notwithstanding its capacity, weight and length it would be easy on itself and the track, which is certainly not the case with the mastodons of "basic design" employed in North America. These non-articulated engines hammer, wrench and pound along metals that are constantly increased in section and weight in a vain effort to keep pace with the ever-mounting stresses they are expected to withstand. This never-ending battle between engine and track has recently led to the adoption by the Pennsylvania Railway of rails weighing 155 lb per yard. Very different would be the behaviour of our plotted "Garratt" articulated locomotive. Content with existing steel, demanding nothing better, it would pursue the even tenor of its way to the North smoothly and fast, flinging the miles behind it, ignoring gradients, making no objection to stops—the "through" passengers would do that! An attractive picture; I wonder if I shall ever see it?

Salvage of Dredger at Port Talbot

By W. F. WARE

WHILST undergoing repairs by the Port Talbot Dry Dock Company on September 25th, 1941, the 850-ton bucket dredger "Don Federico," owned by the Great Western Railway Company, was lying afloat in Port Talbot Dock, across the entrance to a dry dock, moored stem and stern on her port side to the dock-heads. A powerful Dutch refugee steam tug, the "Energie," was moored to the starboard side of the dredger. In the early morning darkness of the "blackout" it was noticed that the dredger was listing to starboard and the captain of the "Energie," a very able tugmaster, had just time to cast off and get his vessel clear as the dredger capsized to starboard, her funnels grazing the side of the tug as she moved away.

The dredger turned over through an angle of 127 deg. and sank with her starboard side partly on the dry dock apron and her heavy 13ft diameter spur wheel which, with its tumbler and shaft, weighed 23 tons, and the top of the central tower buried in the mud at the dock bottom. In this position the casualty completely sealed the entrance to the dry dock (Fig. 1) in which a large oil tanker, the m.v. "Octane," was being overhauled and re-engined. Owing to the age of the dredger, which it is understood was originally built for the Buenos Aires Pacific Railway, it was decided not to attempt to raise the wreck for further use but to remove the obstruction from the entrance and approach to the dry dock. To carry out this work a contract was awarded by the Great Western Railway Company, in November, 1941, to the Ocean Salvage and Towage Company, Ltd., of London, and this work was commenced early in December, 1941.

The Ocean Salvage and Towage Company, Ltd., was established in 1919 and has been engaged on many big jobs at home and abroad during the period of its existence.

Salvage Plan

As shown in Fig. 2, the casualty lay with part of her port bilge about 10ft above water but the stern was completely submerged. It was decided to dispose of the wreck by turning the hull bottom upwards and removing it from the dry dock entrance under compressed air. This plan necessitated the removal under water of all superstructure to about deck level before turning the hull bottom upwards.

As the dredger lay it was prevented from capsizing further by the support afforded by the central tower which lay on the dock bottom. To enable divers to work on the blowing with gelignite and burning off with subaqueous oxy-acetylene torches, of the buckets, bucket ladder, lower tumbler and its shaft, &c., the support given by the central tower had to be maintained. The problem, when these parts were removed, was how to prevent the wreck from capsizing further, whilst the divers were at work in the darkness beneath it, removing the central tower and its shoots, weighing 46 tons; the 9in vertical shaft and its brackets, 6·55 tons, and the big wheel, tumbler and its shaft, 23 tons, &c.

The plan adopted was to parbuckle the hull after lightening it and thus so to cant the hull towards the dry dock entrance that the central tower would be raised from the dock bottom and held safely in the canted position whilst the removal of the central tower and remainder of the superstructure was carried out by the divers and the salvage vessels.

The displacement of the dredger with no fuel, water or stores aboard was 850 tons. By the removal before parbuckling of the bucket ladder (26 tons), lower tumbler and shaft (8 tons), cast iron chocks on ladder (1·8 tons), preventer ropes and brackets (1·72 tons), ladder rollers, spindles and brackets (9·24 tons), buckets, pins and links (70·54 tons), and the bucket ladder pin (2·10 tons), the superstructure could be lightened by 119·40 tons, making the weight 730 tons and the vertical centre of gravity 12·90ft above the keel. Assuming that the hull would cant about the point "O" shown in Fig. 2, the righting moment required would be 730 tons by 14·5ft equals 10,600 foot tons, which force was to be provided partly by the parbuckling tackle on shore and partly by the lift obtainable from a salvage vessel applied to the central tower.

The lift allowed for by the salvage vessel was 100 tons at 37ft equals 3700 foot tons, which left 6900 foot tons for the four parbuckling tackles.

As the required horizontal pull of these four parbuckling tackles applied at a point "A," 4ft above the port bilge of the dredger, would be 6900ft tons/35ft=198 tons, say, 200 tons and as four winches were used, each with its pair of 100-ton purchase blocks, the pull required from each winch and its purchase blocks worked out at 50 tons.

In this figure of 50 tons no allowance had been made for (*a*) friction; (*b*) the unknown load that might suddenly be put on the parbuckling tackles if the hull were to slip in the mud and upset the amount of the loads on the tackles; (*c*) the angle that each of the parbuckling wires made with the longitudinal centre line of the wreck.

Item (*c*) being not more than 2 tons, was negligible and it was assumed that (*a*) and (*b*) were more than covered by the power obtainable from the winches and purchase blocks and by the breaking strain of the ropes, the breaking strain of a 7in wire being 126 tons. It was not expected that the maximum load on any of the parbuckling wires would exceed 80 tons.

To avoid the risk of "bleeding" the floor or the walls of the dry dock by fixing the anchorages or holdfasts for the dead ends of the parbuckling tackles in the floor or on the altars, the first proposal so to anchor the tackles was abandoned and it was decided to adapt for this purpose five concrete bases of the existing bollards along the east side of the dry dock, and along the west side three such bases and two tailend holdfasts to be made of 12in by 12in baulks.

Fig. 1 shows in plan and section the dredger in the capsized position across the dry dock entrance, the four 7in parbuckling wires being two wires from forward and two from aft leading from the casualty to four sets of 100-ton, six-sheave purchase blocks rove with 4in wire and connected to the anchorages with the four 10-ton hand winches in position.

Salvage Operations

As soon as the huts for office, stores, canteen, &c., were erected, labourers and a squad of expert divers and riggers were brought on to the site and the work of removal of the submerged superstructure on the dredger, the preparation of the parbuckling tackle and excavation of trenches for the wires were commenced in December, 1941. At this stage of the operations the floating plant consisted of two diving boats and a 97ft long flush-decked steel vessel called the "Fishguard Barge," which had two catheads and sheaves at the bow and two 5-ton hand winches aft. This barge could lift with purchase blocks about 30 tons from the catheads. The steam tug "Energie" was also available when required.

Before describing the work on the dredger some notes on the construction adopted for the holdfasts on shore and of the parbuckling tackle may be of interest. The concrete bases used as holdfasts measured 8ft by 8ft by 7ft deep below ground level and were all in soft sand. Trenches 6ft deep were excavated between and around all these concrete bases to receive wires and fastenings laid 5ft below ground level. The corners of the concrete bases were reinforced with pieces of disused greenheart placed on end with old sleepers packed on end along the sides of the concrete. Round each base and its timber packing a 7in to 4in by 10 fathoms long wire strop was passed, having thimbles spliced into the ends. The strops on each concrete base were lashed with several turns of 3in to 2¾in wire to the corresponding strops on the next bases in the following manner:

The two thimbles on the ends of each strop were fitted to one end of a pair of heavy roller link plates. The wire lashings were rove through the rollers on one pair of link plates and through the rollers of the plates on the next concrete base and were then hauled taut by a 2½-ton differential chain block and stoppered off with bulldog clips.

In front of each concrete base six 12in by 12in by 16ft long pine baulks were placed one on the other and wet sand was rammed into a heap on one side of the baulks. The strops passed through the baulks 2ft above the bottom of the pile. On the west side of the dry dock the two last holdfasts each consisted of six 12in by 12in by 16ft long baulks in pits 6ft deep with wet sand stacked and rammed against them. The wires passed through the baulks and round greenheart toggles at the backs of the holdfasts.

When attempts were made to sweep messengers under the after end of the dredger for the placing of the 7in parbuckling wires, an obstruction was found which proved to be the dredger's kedge anchor. This, with about 5 fathoms of chain cable, was removed by the salvage vessel "Lady Southborough" chartered from the Admiralty. The placing of the two 7in parbuckling wires round the after end of the dredger then proceeded. The leading ends of the two 7in wires already round the forward end were led aft along the deck under the port bulwark, then through a Panama fairlead in the bulwark, around the vessel and on to the dockhead for connection to the two sets of purchase blocks. The four shoreward ends of these two 7in wires leading from the wreck, two ends from forward and two from aft, had soft eyes formed in them by means of Bullivant 7in wire grips and these eyes were shackled by 100 link plates to the moving blocks of the four sets of 100-ton, 6-sheave purchase blocks. The standing block of each of the four purchases was shackled by 100-ton link plates to a thimble in the end of a 7in pendant. The shoreward ends of these four pendants were also fitted with spliced in thimbles and each of these ends was shackled by link plates to the eyes on its 7in by 10 fathoms wire strop round the nearest concrete base. As sufficient link plates were not available, a number of these was specially made in the dry dock machine shop.

Four 10-ton hand winches were set up as prime movers, being one for each of the four sets of 100-ton purchases and the falls of the 4in wires rove through the six-sheave blocks were led to these winches. Each of the four winches was bolted to the front end of a pair of disused greenheart baulks, 16ft long and about 4ft apart. On the after end of each pair of these baulks 2 tons of old chain cable were stacked as kentledge, and the front ends of each pair of baulks were butted against a 14ft sleeper placed on edge. The baulks and sleepers were sunk in the sandy soil with their tops at ground level, and this arrangement held the winches in position during the parbuckling with no sign of movement.

LONGITUDINAL SECTION OF TRENCH & ONE PARBUCKLING TACKLE ON EAST SIDE OF DRY DOCK.

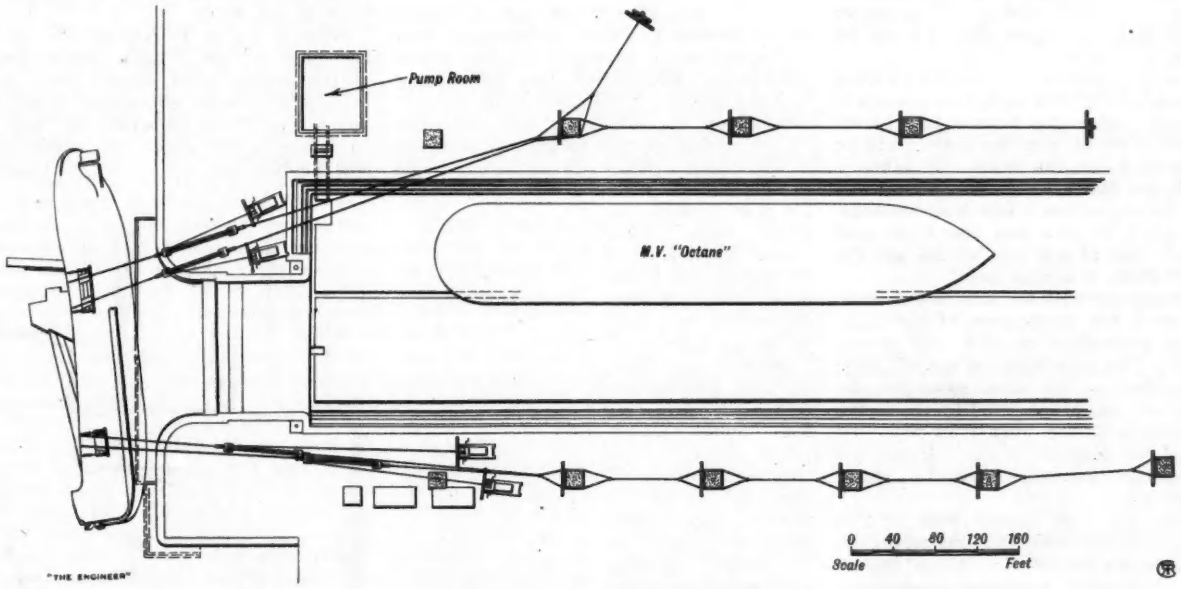


FIG. 1—ARRANGEMENT OF PARBUCKLING TACKLE

Lightening the Wreck

The first work undertaken by the divers to lighten the wreck was the burning through the bucket links with oxy-acetylene torches and in some cases severance was completed with a small charge of gelignite. This work was difficult (as was all the work done by the divers) owing to the angle at which the casualty was lying, to the coldness of the water, and to the poor visibility which was largely due to the coal dust covering the dock bottom.

In spite of the darkness, the divers preferred to work without the powerful submarine electric lamps provided and for which a 10-kW switchboard was secured to the exposed part of the dredger's bilge. Owing also to the angle at which the casualty

lay it was rarely possible that a salvage vessel could give a vertical lift to any of the parts cut away from the tangled mass of gear submerged in almost complete darkness.

There was so much rust between surfaces of the superstructure such as the legs of the central tower and of the bucket-raising gallows which were largely of angle steel, that little or no cutting could be done on these parts with torches, and explosives had to be used. Owing to the close proximity of the caisson and cill at the dry dock

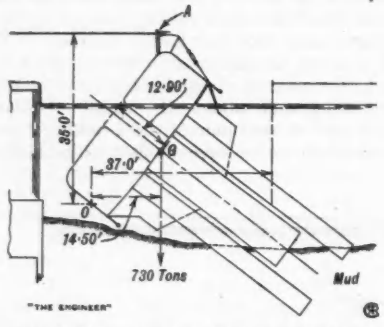


FIG. 2—DIAGRAM OF SUNKEN DREDGER

entrance only small charges of gelignite could be used and these were limited to 5 lb in a single shot.

As soon as enough of the dredger's buckets, which weighed 28¾ cwt each, were removed, the bucket ladder was burned and blown into three sections, and the lower tumbler block removed from the ladder. On January 12, 1942, the fourth leg of the gallows was severed by explosives. This with its head gear weighed 20 tons and was lifted and deposited clear of the site by the salvage vessel "Lady Southborough."

Simultaneously with the underwater work in the wreck the preparation of the holdfasts was proceeding on each side of the dry dock. The excavation of the 6ft deep trenches close to the dock sides for the holdfasts was much hampered by the traffic and materials in the busy dockyard. In one place the bedplate of the "Octane's" engines spanned the trench which throughout was in soft sand.

On January 19th divers with a 2 lb charge of gelignite completed the severance of the first section of the 26-ton bucket ladder. This section was raised on January 23rd by the "Lady Southborough," and landed on the dockhead next day. By January 26th, nineteen buckets had been severed by the divers and put on shore.

On January 29th attempts were made to release the two lower severed sections of the bucket ladder. These were so situated under the sloping deck and jammed between the wreck and the dock bottom as to make the operation very difficult. Owing apparently to the vibrations set up by blasting, the hull had canted a further 3 deg. to starboard, so that it now lay at an angle of 130 deg. from the vertical. On February 3rd the last of the three sections of the bucket ladder was hauled clear of the wreck by the "Fishguard Barge" in conjunction with the "Lady Southborough," and was then landed by the dry dock company's 35-ton steam travelling crane, a veteran of the 1914 war, when it had been used behind the lines in France.

On February 4th shipwrights commenced adzing and shaping 12in by 12in pine baulks to fit the curves of the bilge in the way of the 7in uprighting wires, as shown in Fig. 2. These timbers were to form packing 4ft high and were capped with greenheart supporting curved channel steel chafing plates, in which the 7in wires lay. These timber packings served not only to distribute the pressure of the parbuckling wires over several frames of the old hull, but to give 4ft of extra righting leverage for the parbuckling. On February 9th divers burned through the 9in diameter vertical steel driving shaft in the central tower and also burned holes in the legs of the tower for inserting frames encircled with a special explosive. They also prepared to pass wires under the central tower for the uprighting lift from the bows of the s.v. "Lady Southborough." The weight of the 9in vertical shaft with its brackets was 6·55 tons.

On February 14th the placing of the wire strops with their roller link plates in the trenches round and between the concrete bases for the holdfasts along each side of the dry dock commenced.

On February 21st the divers blasted off the bucket-driving spur wheel embedded in the mud at the outer end of the central tower. This wheel was 13ft in diameter and with its tumbler block and cross-shaft, weighed 23 tons.

UPRIGHTING THE WRECK

On February 23rd at 2.30 p.m. the work of uprighting the wreck commenced with four men heaving on each of the four 10-ton hand-power winches on the parbuckling tackles and the s.v. "Lady Southborough" heaving on the wire strop over the horn on her stem made fast to the central tower of the dredger. By 5 p.m. the dredger was turning over well; her port gunwale had risen about 18in, which showed that the suction due to the mud was broken. Operations then ceased for the night.

On February 24th, at 9 a.m., heaving was continued, with the four 10-ton hand-power winches and with the "Lady Southborough" as on the previous day. After about an hour's intermittent heaving work was interrupted by the strop from the central tower to the salvage vessel slipping and by the after 7in parbuckling wire shearing through the forward side of the Panama fairlead in the port bulwark through which it tore for about 4ft. This wire was then lashed back with wire lashing and union screws, and by 2.40 p.m. the port gunwale had risen about 4ft or about 2ft 6in higher than the previous night, and the dredger was being held in that position by the hand winches on shore. At 2.40 p.m. heaving ceased for the day for overhauling and rearranging parbuckling wires.

On February 26th heaving continued and by the afternoon the flat bottom of the dredger had been canted to an angle of 22 deg. 45 min. from the vertical, which was the limit to which it could be canted without fouling the base of the dockhead. A 7in preventer wire was then put ashore from the after or heavier end of the hull, in order to relieve the winches.

REMOVING CENTRAL TOWER

On February 27th divers removed by blasting the forecastle winch, weighing 8·6 tons, and were also burning through the mud shoots from the central tower. On February 28th divers were occupied in blowing with explosives the starboard side of the central tower. On March 1st divers blew the three legs of the port side of the central tower and the port mud shoot. After severing the port legs of the tower it was found that the 9in dia. vertical shaft which drove the 13ft head wheel was not completely severed by previous burning and blowing. On the morning of March 2nd the severance of the 9in shaft was completed and by noon everything appeared to be cut away to permit of raising the central tower, mud shoots, 9in shaft, &c., but although the s.v. "Lady Southborough" was heaving on it all the afternoon and cuts had been made across the part of the port mud shoot that had been raised above the water, it was not yet possible to haul the tower, with its shoots, vertical shaft, &c., clear of the wreck.

When a 6in by 15 fathom pendant from the horn of the "Lady Southborough" to the central tower carried away it was evident that some submerged obstruction, which the divers had not yet been able to locate in the dark and muddy water, was holding the tower, &c., although the

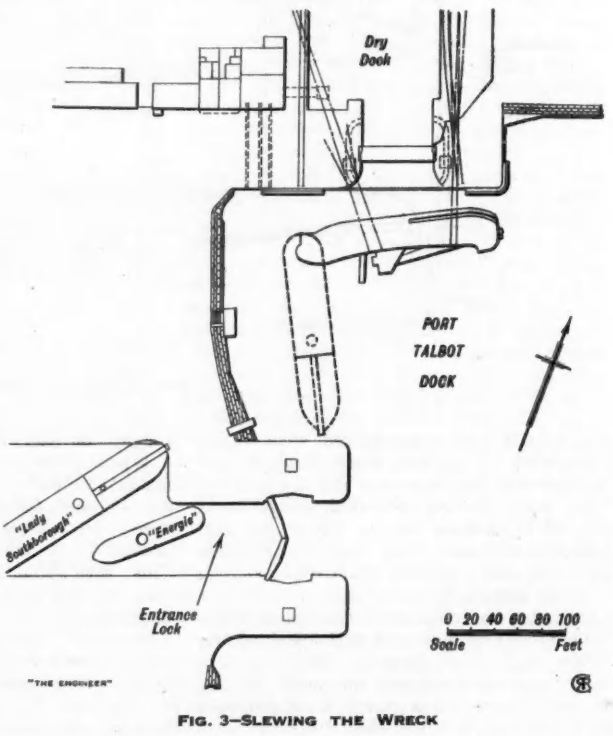


FIG. 3—SLEWING THE WRECK

salvage vessel was able to raise and lower it 4ft or 5ft.

The strop over the "Lady Southborough's" horn was adjusted by the divers in an endeavour to raise the tower, &c., at another angle, with a view to freeing it from any such obstruction. On the afternoon of March 3rd, after the divers had examined the tower and fired more charges, the "Lady Southborough" again commenced

heaving on the wires attached to the tower, and continued heaving steadily until 4.15 p.m., at which time the tower was hove clear of the wreck and hung from the horn on the stem of the salvage vessel.

On the following day, the "Lady Southborough," assisted by the steam tug "Energie" carried the submerged tower with its mud shoots and 9in vertical shaft up the dock to the old locks and deposited the wreckage on the dock bottom within reach of a 12-ton hand crane on the dockside.

Attempts to Raise Dredger

The "Lady Southborough" returned to the dredger and after some blasting was done to remove fittings on the forecastle deck, preparations were made for pumping air into the dredger. Hoses from the air manifold on the "Lady Southborough" were connected to eight of the air cocks fitted on the bottom of the dredger. The air compressors on the "Lady Southborough" were started at 4 p.m., and the parbuckling purchases from the four winches on shore were slacked off.

It was found, on completion of the parbuckling, that there had been very little displacement of the concrete bases forming the holdfasts of the shore ends of the tackles. On the west side of the dry dock the first and the second base had moved ¾in and ⅝in, respectively, toward the dredger, and on the east side the corresponding bases moved forward ⅜in and ¼in. No movement was found in the remaining holdfasts.

The released hull turned over very slowly to starboard so that by 6.30 p.m. her bottom was at an angle of 45 deg. with the water, or halfway to the bottom-up position, so the parrels and brakes were left open on the four 10-ton winches. The air compressors were shut off, divers disconnected the air hoses, and purchases were stoppered off for the night.

On March 5th divers again connected the air hoses from the "Lady Southborough" to the cocks along the bottom of the dredger and the four purchases attached to the parbuckling wires were disconnected so that the hull was free to turn over to the bottom-upwards position, which it lacked by 45 deg. With the tackles released and the air compressors at work, the casualty continued to turn over but very slowly. The bows were buoyant but the stern was pinned down in the mud in such a way that the compressed air could not raise it. It was then decided to rig purchases on the catheads in the bows of the "Fishguard Barge," which was brought into position in readiness for this operation on the following day.

During the morning of March 6th divers placed a 4in wire strop round each of the twin propeller tail shafts of the dredger and connected them to purchases rigged on the barge. With the compressors going and the purchases hove taut the dredger was still buoyant forward but the stern was still held in the mud, although the "Fishguard Barge" was pulled down heavily by the bows. It was then disclosed that the dredger had about 70 tons of chain cable in the after peak as ballast, so it was decided to attempt the lift with purchases rigged on the "Lady Southborough" and two 7in wire strops were placed round the casualty's twin propeller tailshafts in place of the 4in strops. These 7in strops were then connected by 7in lifting wires led over the horn on the stem of the "Lady Southborough," to purchases rigged on her bow ramp in preparation for a lift next day.

On March 7th, during the morning, a 15ft long section of the bucket ladder which had previously been blasted from the dredger was found to be in the way of operations and was lifted clear by the "Fishguard Barge," which was towed by the tug "Energie" and deposited alongside the wreckage of the central tower.

In the afternoon the wreck was again filled with air from the compressors on the "Lady Southborough," which vessel at the same time, with the 7in tackles in her bows, gave a heave on the wreck's tailshafts. With about 150 tons pull on these tackles no movement was observed at the stern of the dredger.

On March 8th and 9th an attempt was made to shift the stern of the dredger by increasing the pull on the 7in wires from the "Lady Southborough" to 240 tons. At the same time a 3in wire was taken from the bows of the casualty to the tug "Energie." The tug then commenced heaving and in doing so continued to sweep in an arc, steering alternately to port and starboard within the limits of the dock. This 3in wire eventually carried away and as the stern of the wreck still remained fast the purchases on the "Lady Southborough" were slackened off and her compressors shut down.

Slewing the Wreck

As shown in Fig. 3, there is in close proximity to the dredger a recess or bay between the S.W. corner of the wet dock and the entrance lock. This bay is longer and wider than the dredger by a few feet and as its landward side is a stone pitched slope it is not used as a berth. It was decided that this bay would be a convenient site for the dredger to be moved to as being quite clear of the approach to the dry dock and also conveniently situated for the breaking-up of the wreck for scrap at a later date. In this way there would also be avoided the risk of taking the capsized hull through the entrance lock of the docks or in towing it to a more remote site further up the dock.

To get the wreck into this bay it was decided to slew the bows through an arc of about 90 deg., away from the dry dock entrance, by pivoting the hull on its stern. For this operation the s.v. "Lady Southborough" would have to take up a position in the entrance lock.

On March 10th the "Lady Southborough" slipped the two 7in lifting wires leading to the tail-shafts of the dredger and took up position in the lock facing the casualty, as shown in Fig. 3, with fascines suspended between her stem and the ashlars of the corner of the lock, against which her bows were placed.

The "Fishguard Barge" was towed into position at the after end of the wreck, and the 7in wires slipped by the "Lady Southborough" were attached to purchases on the barge.

Two air hoses were run from the salvage vessels' compressors to the wreck and whilst the hull was filling with air a 7in heaving wire attached on the previous day to the bows of the wreck by riggers and divers was hauled across the dockhead and over the horn of the "Lady Southborough" to purchases (200 ton 6 sheave) rigged on her winch ramp. The distance from the bows of the wreck to the stem of the "Lady Southborough" was about 330ft.

For the purpose in view, as when heaving on the submerged central tower of the wreck, the two pairs of 6-sheave purchase blocks on the winch ramp of the salvage vessel were rove as one purchase, using a "deadman" roller shackle from a strop round the mast, where it entered the winch ramp. The common purchase thus obtained exerted an even strain on two wires, irrespective of the prime movers, which in this case were two of the "Lady Southborough's" steam winches. The s.t. "Energie" came alongside the salvage vessel in the lock and secured a 3in towing wire to the casualty.

At 5.35 p.m. heaving was begun simultaneously by the "Energie" and the "Lady Southborough," the wreck pivoting round steadily. At 6.30 p.m. heaving ceased to adjust purchases on the "Lady Southborough" and was continued from 7 p.m. to 7.20 p.m. and from 9 p.m. to 9.20 p.m., when the dredger was in the bay and quite clear of the entrance and fairway to the dry dock. Operations then ceased for the night.

On March 11th "Lady Southborough" and "Energie" took up their positions of the previous day and heaving was resumed at 4.35 p.m. and at 4.45 p.m., the forepart of the dredger had been pulled about 20ft further into the bay, which was the desired position and operations ceased. The final position of the wreck is shown dotted in Fig. 3.

Sweeping was then carried out in the approach to the dry dock, which ensured that no obstacles were left on the bottom of the dock.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1.

INSTALLATION AND MAINTENANCE OF FLAMEPROOF AND INTRINSICALLY SAFE ELECTRICAL EQUIPMENT FOR INDUSTRIES OTHER THAN COAL MINING

C.P. 1003 : 1948. This Code of Practice has been drafted by a Committee convened jointly by the Institution of Electrical Engineers and the British Standards Institution. It offers guidance in the selection, installation and maintenance of flameproof and intrinsically safe electrical equipment for industries other than coal mining. The use in industry of processes employing inflammable solvents, or other inflammable or explosive materials, gives rise to dangers of fire or explosion, from the ignition of the associated gas, vapour, liquid or dust. As a result, it has been found that there is a need for authoritative guidance on the procedures to be adopted in relation to the use of electrical equipment where such risks are encountered. The Code points out that no electrical apparatus should be installed in areas where explosive or inflammable atmospheres normally persist, and emphasises that its recommendations are only intended to apply to other areas where the risk is liable to arise or where it may arise under certain emergency conditions. A section of the Code deals with intrinsically safe circuits and apparatus, and indicates the conditions under which these may be used and the necessary precautions which must be adopted. Price 2s. post free.

COPPER FOR ELECTRICAL PURPOSES

B.S. 1432, Sheet and Strip; B.S. 1433, Bar and Rod; B.S. 1434, Commutator Bars. These three standards supersede the existing specifications B.S. 444, Plain, Dead-Soft Copper Strip, Bars and Rods, for the Windings of Electrical Machines; B.S. 445, Copper Commutator Bars for Electrical Purposes; B.S. 518, Medium-Hard Copper Strip, Bars and Rods for Electrical Purpose; and B.S. 1110, Hard Copper Sheet and Strip for Electrical Purposes. The new standards have been rearranged in a more logical sequence, each form of material being included in a separate document. The scope of the specifications has also been modified so that the definitions conform to the British Standard definitions for wrought products recently published as B.S. 1420. The standards contain requirements concerning quality of material, finish, dimensional tolerances, tensile properties and electrical resistance. They also include a table of temperature coefficients of resistance. Price 2s. post free.

Radiographic Tyre Testing

CONVENTIONAL methods of tyre testing suffer from the limitation that many kinds of internal defects cannot be revealed by the usual non-destructive factory tests based on visual examination, dimensional and weight tests, and measurements of deflection and hardness. The possibilities of bridging the existing gap, by applying radiographic technique to the examination of tyres at various stages of manufacture, have long been appreciated by the Dunlop Rubber Company, Ltd. Radiography as applied to therapy and the examination of castings could not, however, be used in the tyre industry without adapting the technique to suit the needs of a new medium. In fact, more than two years elapsed before the radiographic examination of tyres graduated at Fort Dunlop from the laboratory stage to the status of an established works test technique. Some of the difficulties that had to be overcome were made clear on a recent visit to Fort Dunlop, when we were favoured with a demonstration of the process.

In choosing X-ray apparatus suitable for tyre testing two main requirements had to be considered. In the first place, it was necessary to use an X-ray tube with accelerating potentials variable over a very wide range to suit the various thicknesses of material involved in comparatively thin walls combined with very wide treads. An important factor, closely associated with this requirement, was that both cotton and rubber have approximately the same opacity to X-rays. Close control of exposure and development was, therefore, a primary requirement and in many instances the necessary contrast could only be obtained by using lower accelerating potentials to produce comparatively "soft" rays.

The second important requirement was that the projected area of the target should be as small as possible. Without a small target, approximating to the ideal "point source," it would be impossible to obtain a sharp image when projecting both walls and the tread of a large tyre, such as the one illustrated herewith.

At the time when these requirements were first formulated, during the war, the apparatus complying most nearly with the desired specification was an X-ray unit (Victor KX 140), manufactured by the General Electric Company of America, and developed initially for the examination of light alloy castings. This equipment has a useful range of accelerating potentials varying from 140kV down to 28kV, and the tube embodies a target with a projected area in the direction of the beam of approximately 1·6mm square. This small target, which is essential for obtaining fine detail, limits the power dissipation in the tube, but increased exposure can be given to compensate for the sacrifice of power.

Various views of the equipment are reproduced herewith, and it will be seen that the lead-sheathed working head containing the tube can be swung about two mutually perpendicular axes and locked in any desired position. The cradle mounting carrying the working head is counterbalanced to slide easily up and down the tubular supporting column, and it can be locked in position at any convenient height above the floor. A wheeled platform at floor level forms the base for this supporting column, giving the necessary mobility. Flexible cables connect the tube to the supply unit, which is not shown in the accompanying illustrations. This unit, consisting of a standard 70–0–70-kV centre-tapped transformer and valve rectifier, is completely oil immersed in a steel tank with a plate glass inspection window fitted in the lid.

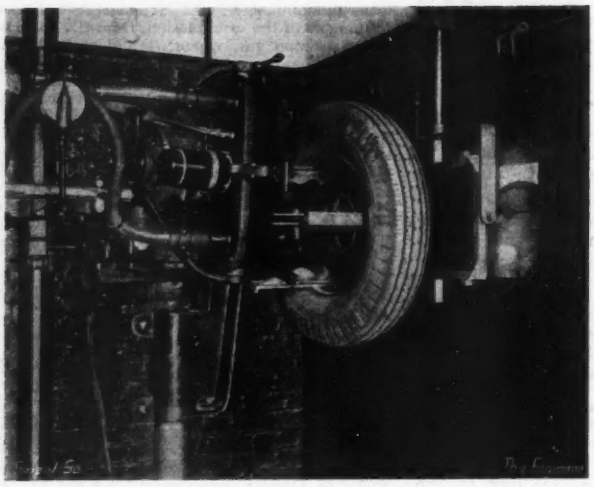
EXAMINING AN AERO TYRE

Broadly speaking, the apparatus can be used in two ways. First, where a permanent record is wanted, a negative image of any particular part of the tyre can be produced on photographic film. Secondly, rapid visual inspection of a tyre can be made by interposing it between the tube and a fluorescent screen coated with barium platinocyanide upon which an image is projected similar to that obtained on the screen of a cathode ray tube. The arrangements for this kind of visual inspection are indicated in one of the photographs reproduced herewith. For convenience the tyre is mounted in a three-jaw chuck which was designed at Fort Dunlop specially for this work. The chuck spindle is driven by a small variable-speed geared motor, which causes the tyre to rotate at a convenient controlled speed for visual examination. The tyre chuck is mounted on a portable stand and for a test the tyre is set up between the tube and the screen as shown. By altering the attitude of the tube the examiner can, if it suits his purpose, obtain an oblique view of the tread or walls. Although large aero tyres are usually examined in the manner illustrated herewith, these tyres can, we are informed, be supported satisfactorily by the chuck and stand already described. To simplify handling of large tyres the projection room is provided with an overhead gantry.

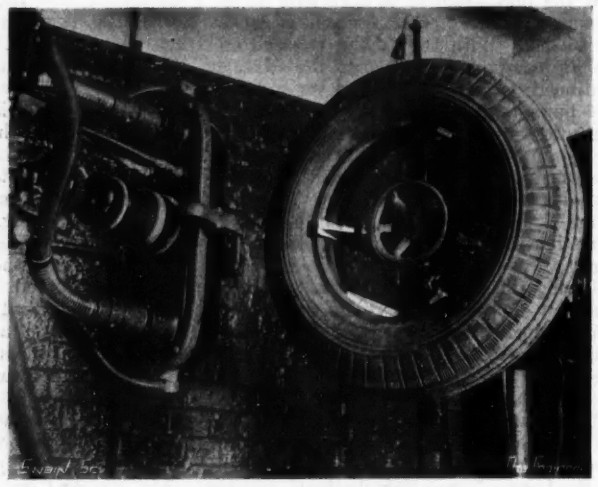
When carrying out a test the examiner is stationed in an adjoining room separated from the projection room by a sliding door built up of ¼in lead sheet sandwiched between wooden panels. As shown in our illustration the door contains a lead glass inspection window. This door constitutes physically the first of a number of safety precautions. As already stated it separates the projection room from the inspection room which houses the main control panel. This panel is so arranged that the supply to the X-ray equipment is "on" only when the sliding door is properly closed so as to make contact with a limit switch. This implies that no radiation can be taking place unless the lead-protected door screens the operator from the tube. The brick walls of the equipment room are 14in thick, while ceilings and floors embody a protective layer of barium plaster.

The inspection room gives access, on the one hand, to a well-appointed processing room, and, on the other, to an office equipped for viewing negatives on an illuminated screen, as well as for recording. Nothing but X-ray work is handled in the dark room, which contains provision for wet viewing of urgent negatives and for quick drying. Normally, printing is not required, the negative being viewed as a transparency, but for certain special problems such as cycle valves and other small parts, enlarged prints (×5) are made.

One of the very useful accessories to the X-ray equipment is a stereoscopic binocular whereby the optical effect of the third dimension can be reproduced from pairs of stereo



ARRANGEMENT FOR SCREEN VIEWING

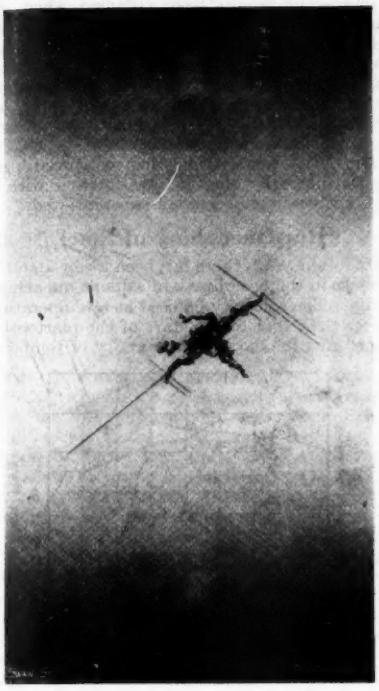


PHOTOGRAPHING TYRE WALL

radiographs. In this way the depth of faults in thick structures can be evaluated.

Some Applications

The Dunlop X-ray testing department is used in the first place to supplement the normal methods of tyre inspection by yielding definite evidence in instances where the factory viewers may be doubtful about a suspected defect in a tyre. By comparing results of X-ray and visual examination in this way the standard of factory inspection can be improved. Secondly, radiographic testing can be used to carry out additional tests on portions of current production which would be impracticable if each tyre had to be broken down for examination. Thirdly, the Dunlop Rubber Company, Ltd., has developed and adapted radiographic methods for research tests on tyres to acquire information which, in many instances, could be obtained in no other way.



Size 9·00 × 20, Anode Voltage 42-kV, Target/Filament Distance 40in, Anode Current 5mA, Exposure 2 min.

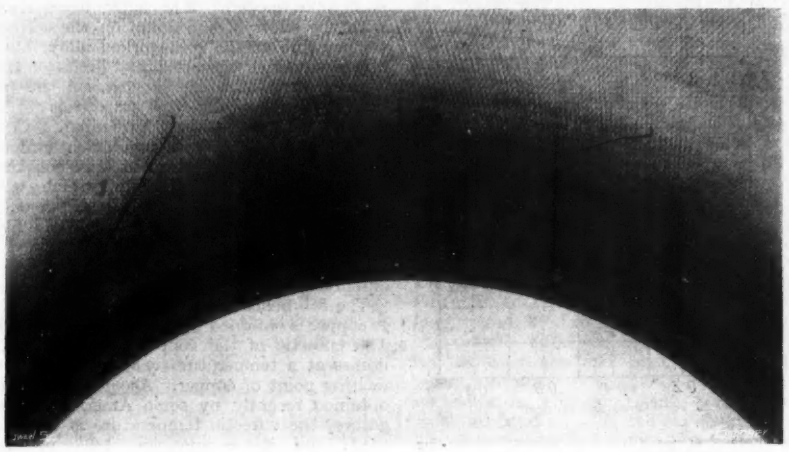
Cavity in Tyre Tread

Various examples demonstrating the versatility of the technique are illustrated in the photographic prints reproduced herewith.

The first example on this page shows the method devised for a special test to determine the extent of the cavity produced by intentional impact in the tread of a part-worn tyre. Mercury was injected into the tyre at the point of impact, filling the main cavity and running along the fabric thread in those places where the rubber-fabric bond had been destroyed. Some detail is inevitably lost in the reproduction, but the original transparency clearly shows the extent of fabric separation.

Our second illustration is reproduced from a radiographic print giving an oblique view of an inner tube joint. Steel dust was introduced into the tube so as to show lifting of the internal bevelled edge of the joint. Wherever lifting occurred the fact was made apparent by the steel dust lodging in the crevices and causing an opaque shadow on the sensitive screen. This technique is interesting inasmuch as ordinary X-ray methods would fail to reveal the separation, since lifting of the bevelled edge at any point involves no change in the total thickness of the rubber wall.

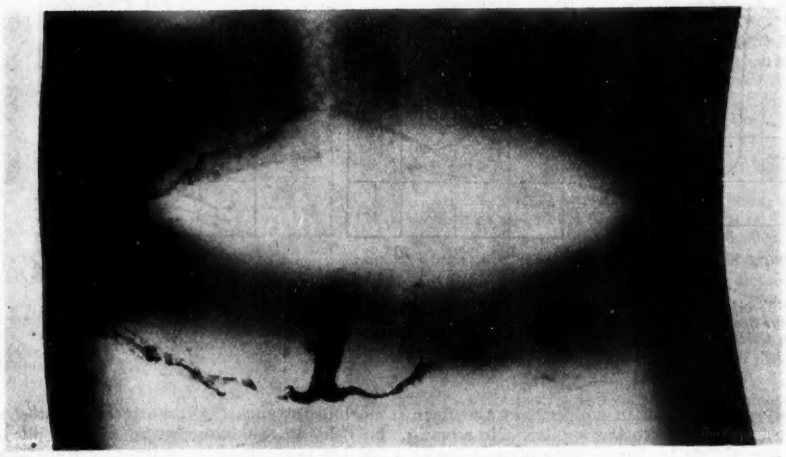
The third radiograph reproduced herewith was taken as part of a special investigation. Thin wire indicators were inserted between the fabric layers of a small aeroplane tyre at appropriate stages to show whether creasing of the fabric occurred during any of the manufacturing processes. Each length of wire followed the same direction as the adjacent individual strands of fabric. In this particular tyre creasing of the fabric, at a short distance from the bead, was indicated clearly by a pronounced kink in the otherwise straight portion of each piece of wire. This evidence supported and supplemented the information obtainable from subsequent stripping and sectioning of the tyre.



Size 8·50 × 10, Anode Voltage 38-kV, Target/Filament Distance 40in, Anode Current 5mA, Exposure 1½ min.

Fabric Creasing

These illustrations embrace some of the specialised applications of radiography in the tyre industry. No less valuable however, is the use of this technique as an important auxiliary to visual inspection in routine tests. For example, many defects, such as bent bead wires, can be detected with great certainty by viewing the radiographic image of the tyre on the fluorescent screen. No further elaboration is needed to show that X-ray examination is a versatile tool with a sphere of usefulness embracing factory production as well as the laboratory, and one which the Dunlop Rubber Company, Ltd., is justified in regarding as an important element in the company's efforts to maintain and improve the standard of tyre quality.



Size 36 × 8 (Butyl), Anode Voltage 30-kV, Target/Filament Distance 40in, Anode Current 5mA, Exposure 2 min.

Separation at Bevelled Joint in Inner Tube

South African Secondary Industries

Some idea of the growth of industrial developments in South Africa may be gleaned from the fact that last year the gross output of secondary industry increased to £341,000,000, compared with £96,000,000 from the gold mining industry and £120,000,000 from all forms of mining. Within five years the Union's industrial output has been doubled, the physical volume of production increased by more than two thirds and the number of employees in secondary industry by about one third. More and more British industrialists are coming to the Union to establish new ventures. Without exception these men, versed in British industrial techniques, have expressed confidence in the future of the Union. Sir George Usher, whose £350,000 Aberdare Cable Works at Port Elizabeth have already started production, in referring to the bright industrial future of South Africa, said : "I believe that only the surface of the country has been scratched as far as potential development is concerned." The engineering industry, which is the basis of all industry, is now producing goods in the Union, comparable with those of more experienced countries, as is shown by the sale of such items as electrical gear, in countries as far apart as Malaya and South America.

Metallurgical Topics

Copper-Chromium and Copper-Nickel-Chromium Alloys

COPPER-CHROMIUM alloys containing a small percentage of chromium have been the subject of numerous patents in this country and in America.* Altogether these cover compositions ranging from 0·08 to 3·0 per cent of chromium and many refer to heat-treatment, e.g., reheating a casting or forging which has been quenched or otherwise cooled to below 200 deg. Cent. The main application of copper-chromium alloys is for electrical purposes, particularly where elevated temperatures are involved. Good mechanical strength and high conductivity make the suitably deoxidised low-chromium alloys useful for transmission lines. Other applications of copper-chromium alloys are as castings or forgings for cylinder heads and other parts of internal combustion engines, for roofing and for the manufacture of certain chemical equipment.

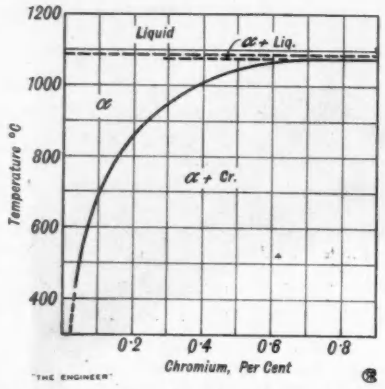


FIG. 1—*Part of Copper-Chromium Diagram Indicating Solid Solubility of Chromium in Copper*

The properties of a copper-chromium alloy casting have been tabulated by M. G. Corson.† W. O. Alexander,‡ in a study of these alloys, found that in circumstances which conduce to a large grain structure, such as exposure to a high annealing temperature after cold working, the presence of chromium materially restricts grain growth so that only the normal grain size is developed. Alexander dealt mainly with the effect of chromium on the softening temperature of the cold-worked alloy, but he also determined the solubility limits of the α solution and, of course, recognised the possibility of modifying the properties of the alloys by precipitation hardening. C. H. Davis§ examined the precipitation-hardening properties of copper-chromium wire containing 0·89 per cent of chromium, which would appear to be an unnecessarily high percentage in the light of recent knowledge. He found that the greatest strength was obtained by homogenising at 1000 deg. to 1025 deg. Cent. and precipitating at 425 deg. to 500 deg. Cent.

The full benefit of the addition of chromium to copper is obtained with very little chromium. The eutectic of the copper-chromium system occurs at a temperature very little below the melting point of copper. According to results obtained recently by some American investigators‖ the eutectic temperature is 1070 deg. Cent. and its composition 1·33 per cent chromium. The chromium in solid solution at the eutectic temperature was between 0·61 and 0·75 per cent. The solubility line, shown in Fig. 1 is in good agreement with that of Alexander except in the vicinity of the eutectic temperature. Not more than 0·38 per cent of chromium will pass into solid solution in copper at 1000 deg. Cent. Below 400 deg. Cent. its solubility is less than 0·05 per cent.

The American investigators were seeking a copper-base alloy with high strength, and selected the copper-nickel system as the basis for small additions of chromium. The eutectic temperature was raised by 10, 20 and 30 per cent of nickel to 1080 deg., 1105 deg. and 1120 deg. Cent. respectively. The solubility of chromium in the cupro-nickel alloys was slightly greater than in copper, but the form of the solubility curve was similar. No advantage was shown by the ternary alloys, except in a somewhat higher softening temperature. Copper with 0·48 per cent chromium (1050 deg. for four hours, water quenched; 450 deg. for four hours), and 70 : 30 copper-nickel with 0·56 per cent chromium (1070 deg. for four hours, water quenched; 600 deg. for twelve hours or 650 deg. for four hours) gave similar hardness values, and no additional hardness was found in the 10 or 20 per cent nickel alloys.

Interesting results were obtained when the solution treatment and water quenching were followed by cold rolling before the final ageing treatment was applied (Fig. 2). With this treatment also the binary copper-chromium alloys attained approximately the same, or greater, hardness values than the ternary copper-nickel-chromium alloys.

Thus, the expectation that enhanced properties might be obtained by starting with a superior basis metal was not substantiated.

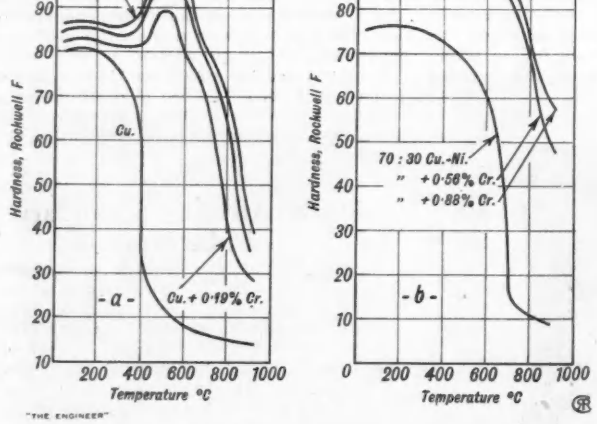


FIG. 2—*Hardness of* (a) *Copper and* (b) 70 : 30 *Copper-Nickel with Chromium Additions. Solution Treated* (a) *at* 1050 *deg. Cent. for* 4 *Hours,* (b) *at* 1070 *deg. Cent. for* 4 *Hours, then Cold-rolled* 20 *per Cent Reduction in Thickness and Annealed for* ½ *Hour at the Temperature Indicated (Hibbard et al.).*

Hot-Quenching of Steel

Of recent years there has been a considerable increase in the use of molten salts as quenching media. The salt may be used at a temperature higher than that of the start of the martensite transformation, so that uniformity of temperature throughout the material may be almost completely attained before the steel is removed from the salt bath and cooled through the martensite range. Alternatively the steel may be held at the temperature of the salt bath until it is partially or completely transformed.

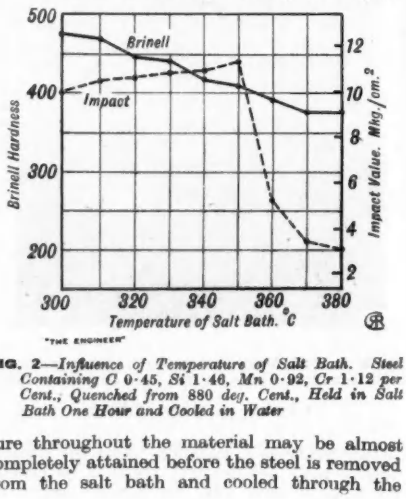


FIG. 2—*Influence of Temperature of Salt Bath. Steel Containing C* 0·45, *Si* 1·46, *Mn* 0·92, *Cr* 1·12 *per Cent., Quenched from* 880 *deg. Cent., Held in Salt Bath One Hour and Cooled in Water*

Payson and Hodnapp,* in their study of the "austempering" process, some years ago described experiments in which small specimens of some S.A.E. low-alloy steels were quenched from suitable temperatures above their critical points in baths at from 800 deg. to 300 deg. Fah. (425 deg. and 150 deg. Cent.), held for five, fifteen, thirty and sixty minutes and then

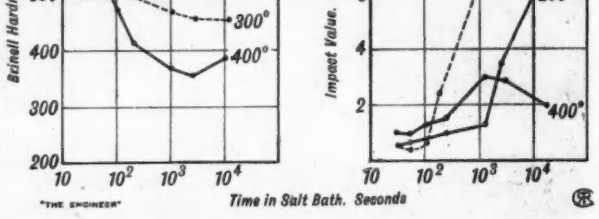


FIG. 1—*Effect of Time in Salt-Bath on Brinell Hardness and Impact Value of Steel Containing C* 0·43, *Si* 1·54, *Mn* 0·96, *Cr* 1·08 *per Cent, Quenched from* 880 *deg. Cent., Cooled from Salt-Bath in Water*

* For example, British Patents 461,845 (D. P. C. Neave and H. J. Miller) and 483,237 (H. W. Russell and E. R. Darby); U.S. Patents 1,723,867 (M. G. Corson), 2,148,151 (E. R. Darby) and 2,281,691 (F. R. Hensel and E. I. Larsen).

† M. G. Corson, *Iron Age*, Vol. 142, 1938, No. 15, page 78; No. 16, page 25.

‡ W. O. Alexander, *Jour.*, Inst. of Metals, 1939, Vol. 64, page 93.

§ C. H. Davis, *Wire and Wire Production*, 1938, Vol. 13, page 565.

‖ W. R. Hibbard, Jr., F. D. Rosi, H. T. Clarke, Jr., and R. I. O'Herron, Amer. Inst. Min. Met. Eng., Tech. Pubn. No. 2317, *Metals Technology*, Vol. 15, No. 2, February, 1948.

* P. Payson and W. Hodnapp, *Metal Progress*, April, 1939, Vol. 35, page 358.

finally quenched in water. Hardness tests on these samples showed that all grades were completely transformed in less than one hour at all temperatures between 425 deg. and 150 deg. Cent., and in most cases in less than thirty minutes.

A somewhat similar series of experiments has been carried out by W. Connert and H. Kiessler† on a steel containing carbon 0·45,

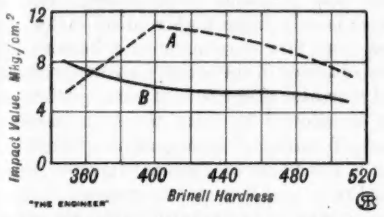


FIG. 3—*Impact Value in Relation to Hardness in Cr-Mn-Si Steels (Average of Five Melts) Treated by Alternative Methods: A, Quenched in Salt Bath; B, Oil Hardened and Tempered*

silicon 1·4, manganese 0·9 and chromium 1·1 per cent, quenched (usually from 880 deg. Cent.) in a salt bath at 200 deg. to 400 deg. Cent. for times up to three hours and then cooled in water. The tests applied were mainly Brinell hardness and notched bar impact tests, and the principal effect found, under favourable conditions, was an improvement in impact value produced by this intermediate stage treatment as compared with that resulting from the usual method of hardening and tempering, in material within the limited range of tensile strength of 140kg to 170kg per square millimetre, the latter value being the highest attainable by isothermal transformation of this steel. These values are approximately equivalent to 400 to 500 Brinell.

In this connection it is of interest to note that Payson and Hodnapp's curves showed that in the Rockwell hardness range C44 to C53 (approximately 420 to 530 Brinell) the "austempered" steels were definitely superior in toughness. They concluded that for alloy steel parts which were to be used with a Rockwell hardness number below about C42 the conventional oil-hardening and tempering was superior to the austempering treatment when maximum toughness is required. Connert and Kiessler's results lead to the same conclusion.

The chromium-manganese-silicon steel used responded to intermediate stage treatment in

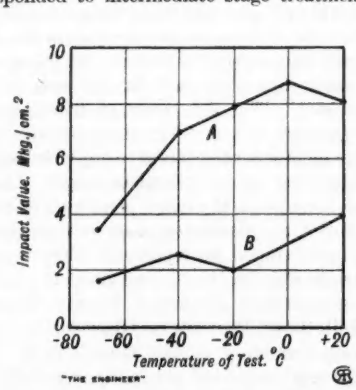


FIG. 4—*Impact Value at Low Temperatures of Steel as in Fig. 1, Treated by Alternative Methods: A, Quenched in Salt Bath; B, Oil Hardened and Tempered*

sizes up to 30mm by 30mm. The highest impact values were obtained after treatment in a salt bath at 300 deg. to 350 deg. Cent. (Figs. 1 and 2). When the temperature of the bath exceeded 350 deg. the impact value of the products fell rapidly (Fig. 2). Impact figures for material treated by the alternative methods to give the same hardness (average of five melts) are shown in Fig. 3. In the favourable range of hardness, i.e., about 400 to 500 Brinell, the intermediate stage treatment brought about not only an increase in notched bar impact value, but also an increase in elongation and reduction of area, and of impact value at low temperatures (Fig. 4). These results were confirmed on additional casts of Cr-Mn-Si steel and on a variety of low-alloy steels containing chromium with molybdenum or vanadium.

An attempt was made, without success, to obtain improved properties in the lower hardness range by modifying the composition of the steel. It was not found to be possible, by the use of softer steels, to displace to a lower strength level the region in which the intermediate stage hardening showed favourable results.

Connert and Kiessler attribute the increase in toughness induced by isothermal treatment at 300 deg. Cent. to the "diminution of temper-brittleness," giving Fig. 5 in confirmation of this opinion; but, in view of the range of hardness in which, alone, the improvement is noticeable, it was pointed out in the discussion of the paper that the type of embrittlement eliminated by isothermal treatment appears to be the brittleness developed by tempering the oil-hardened steel at moderately low temperatures. Tempering at 250 deg. to 350 deg. Cent. often results in impact properties inferior to those obtained by tempering at still lower

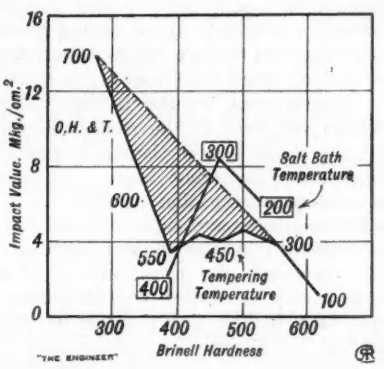


FIG. 5—*Dependence of Impact Value on Hardness of 10mm by 10mm Specimens of Steel as in Fig. 2, Treated by Alternative Methods. (The Dotted Line Represents the Probable Course of the Curve Without Embrittlement.)*

temperatures in spite of the fact that the hardness is not so great. This brittleness on low-temperature tempering has not yet been investigated in much detail, but is quite distinct from the reversible precipitation phenomenon correctly described as "temper-brittleness."

The paper by Connert and Kiessler, while indicating the possibilities of intermediate stage hardening, also shows that this form of treatment can only be applied with advantage to material of limited dimensions, intended to give a Brinell hardness of about 400 or more.

Hardenability

AN interesting series of lectures is being given weekly at the Ecole Centrale des Arts et Manufactures, Paris, under the auspices of the Centre d'Etudes Supérieures de Métallurgie, of which Monsieur Portevin is the President. It is an organisation founded by Monsieur Léon Guillet with the object, each year, of focussing attention on present-day metallurgical developments, both theoretical and practical, in France and abroad, and particularly on their technical applications. The lectures, which take the form of critical surveys of the appropriate subject matter, are being fully reported in *La Métallurgie*, in the January issue of which the programme for the session was given. The lectures cover a wide field including manufacturing processes, mechanical and heat-treatment of products, and their physical and mechanical properties.

Some have already been reported. The March issue contained the text of the lecture by Monsieur R. Girschig on the application of methods of statistical analysis to problems of control and research in industry. In the April number a well-illustrated report appeared of a lecture by Monsieur Robert Jung on the electrical control of cold-rolling mills, and also an account of the recently formed Institut de Recherches de la Sidérurgie, its programme of work and the immediate developments contemplated in the way of new laboratories, &c., which formed the subject of a lecture by Monsieur Henri Malcor, Director of Scientific Research at the Ecole Centrale.

The lecture reported in *La Métallurgie* for May, 1948, was given by Monsieur J. M. Vialle on the assessment of steels by chemical analysis and by the Jominy test. The lecture consisted largely of a review of published work, amplified by the experience of the author as head of the laboratories of the Aciéries de la Marine at Saint-Chamond.

He pointed out, for example, that in these laboratories the Charpy-Grenet test for the depth of penetration of the hardening effect in steel had been utilised since 1922, not only for controlling the thermal treatment of thick armour plate, but also for comparing the depth of penetration of the quenching effect in various constructional steels. Bars of various steels, 20mm by 20mm in section and 150mm long, were heated to 850 deg. Cent. The upper part of the bars was covered with asbestos, leaving only one end bare. The specimens when uniform in temperature, were placed vertically in a support and sprayed under standard conditions on the exposed base by a jet of water (orifice 2·5mm diameter, 10mm from the face to be quenched, pressure 1kg). When the bar was completely cool the hardness was determined on the sides at different distances from the base. This test may be regarded as a forerunner of the Jominy test which was introduced in 1938.

Vialle concluded that neither composition nor Jominy hardenability, alone or jointly, gave sufficient information to enable an accurate forecast to be made of the behaviour of a steel. He rejected the idea that the same structure necessarily implied the same mechanical characteristics or that steels of the same hardenability are perfectly suitable for the same use; but in making these reservations he did not wish to disregard the importance of the American studies on hardenability. The volume and scope of this work was accounted for by the principle adopted in the U.S.A. of choosing for a given component the steel having the lowest hardenability compatible with the conditions of use. Such a rule implied a very strict control of hardenability and was no doubt justified on economic grounds, especially in wartime. The work of Grossmann and of Jominy had found important practical application in the development of the N.E. steels. It had given valuable indications for the replacement of scarce elements by others in such a way as to conserve supplies of steels of good hardenability. The lecturer had been struck repeatedly by the difference, often enormous, in the amount of alloy element used for the same component in France and in America.

In Vialle's opinion it would be premature to introduce the Jominy test as a specification test. In American specifications fixing upper and lower limits of hardenability, the curves have usually to be rather far apart, which, independently of all other considerations, diminishes the value of the test. Nevertheless, he regarded the Jominy test as a valuable preliminary test of selection, though not as a means of showing that a steel could or could not be used for a certain purpose. He thought it should be supplemented, as was the practice in France and in particular in the laboratories of the Aciéries de la Marine at Saint-Chamond, by a systematic study of the penetration of the hardening effect in specimens of increasing diameter so that for each diameter it was possible to obtain the curve of hardness in a vertical section in the quenched condition, and the mechanical properties at various distances from the outside in the quenched and tempered steel. Such tests had none of the characteristics required for an acceptance test; but, though long and expensive, they provided trustworthy information on which further study of variations in hardenability and of the relation between structure and mechanical properties might be based.

† W. Connert and H. Kiessler, "Studies on the Practicability of Intermediate Stage Hardening," *Stahl und Eisen*, April 22, 1948, Vol. 68, page 137.

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NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

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THE A.E.U. AND WAGES

IN these days of economic difficulty a very considerable responsibility has been thrown upon the leaders of trades unions. The day has long since gone by when they could single-mindedly concentrate upon safeguarding and promoting their members' interests without giving much, if any, consideration to the interests of employers. Strikes are, indeed, always damaging to the community as a whole if only because a proportion of possible production is thereby lost and the nation is therefore necessarily that much the poorer in material wealth. But when Britain still retained some pretensions to being "the workshop of the world," and when, moreover, the numbers likely to be involved in a single strike were small, the loss was not very serious. To-day, however, conditions are very different. Had the Amalgamated Engineering Union, for instance, countenanced a strike over the recent rejection of the wage claim put forward by the Confederation of Shipbuilding and Engineering Unions over 800,000 people would have been involved and the consequences to the country of a stoppage of work in an industry that is contributing so heavily and so successfully to the export drive would certainly have been very serious, and might have been little short of disastrous. The members of the union would, too, have been amongst the first to suffer from the inevitable consequent contraction of oversea trade and the resultant widespread unemployment in this country.

It is therefore encouraging to realise that Mr. Jack Tanner obviously had such reflections in mind when making his Presidential Address to the National Committee of the A.E.U. at Brighton last week. He pointed out that the field of trade union interests and activities had widened considerably in recent years. No doubt he was referring to the fact that union representatives now take quite a prominent part in the work of the numerous committees and councils which are sponsored by the Government for investigating and advising upon such matters as planning, production, manpower, exports, and education, and that the unions are represented on the boards of those industries which have been nationalised. It is true that he also reminded the A.E.U. committee that the unions' traditional function of safeguarding and promoting their members' interests "remained supreme." But he went on to suggest that the task of safeguarding and promoting the workers' interests, particularly those related to the wages question, became more complicated and difficult when considered in the light of the present state of the nation. Those sensible references to the responsible part that the union is now playing in national affairs must have gone far in influencing the subsequent rejection of a motion for strike action by twenty-eight votes to twenty-three when the matter of the rejected wage claim came up for consideration. That claim, it may be recalled, was submitted on April 14th by the Confederation of Shipbuilding and Engineering Unions, and was for a national minimum consolidated rate of £5 15s. a week for skilled men, and of £5 for unskilled men, or, briefly, for an increase of 13s. a week. After careful consideration, the Engineering and Allied Employers' National Federation rejected it on the ground that it was in direct conflict with national necessity, as a general increase in wages inevitably meant an increase in the cost of production, and increased production costs could do nothing but support an inflationary tendency by pushing up the prices of goods. Furthermore, in the Federation's view, the claim was for a substantial increase in wages irrespective of the existing position of real earnings. Naturally, many arguments in support of the claim were advanced at the A.E.U. Committee's debate. The increase in engineering production since April, 1946, the increased profits of engineering concerns, and the increased cost of living were all put as points in defence of the demand. But finally, the Committee agreed unanimously to support a demand for the setting up of a Government Court of Inquiry into the general wage anomalies and profits in the engineering industry.

The A.E.U. National Committee is certainly to be commended for discouraging those of its members who evinced a desire to resort to strike action. For such action could not lead to any satisfactory issue, and, in the engineering industry particularly, would only add considerably to the nation's economic difficulties. Yet it is disquieting that so many of those who spoke at the conference still appear to cling to false ideas. The profits of engineering concerns have certainly been higher lately. But to suppose that they are so high as to be able to cover a wage increase of 13s. a week without an increase of prices is just plain nonsense. Nor, in reality, is there much sense in claiming a wage increase because the cost of living has risen. For the standard of living in this country cannot rise, however much wages may rise, until there is a freer flow of goods to the shops. Higher wages merely mean higher prices. Nor can that freer flow develop until a balance has been obtained in the country's overseas trade, and a greater proportion of home production can be allowed to reach the home market. That, of course, is the argument advanced in the White Paper on Personal Incomes, Costs and Prices, and it cannot be gainsaid. Certainly the general wages structure in the engineering industry seems to need examination. But the time to undertake that work will not arrive until the country has safely solved its economic problems. Those problems will be all the more quickly solved if for several months ahead nothing occurs to force up prices and so hinder an increasing flow of exports.

THE "MECHANICALS" AT GLASGOW

How pleasant it was last week to attend again a real Summer Meeting of the Institution of Mechanical Engineers, after the long intermission imposed by the war! It is true that only in a limited sense could it be regarded as the first of such meetings to be held by the Institution since the beginning of the war. For though the big function in London last summer was a Centenary Celebration, not a Summer Meeting, its organisation was very similar and it had the same mixture of technical sessions, visits to works and social functions that we associate with the Summer Meeting. But very fine and very appropriate though last year's celebrations were, there were too many people taking part, too many eminent guests from other nations, too strong a feeling that the eyes of engineers the world over were watching the proceedings for the true, traditional flavour of an ordinary summer meeting to be tasted. At Glasgow last week, however, that flavour was fully recaptured. The old sense of friendliness and intimacy returned. Here was a meeting for the members themselves to enjoy without consideration of what others might think about them; and the usual perfection of the Institution's organisation ensured that their enjoyment should be unalloyed. Nor could a warmer welcome have been provided than that so genially expressed by Sir Hector McNeill, Lord Provost of Glasgow, at the opening ceremony in the Royal Technical College and repeated again in less formal terms at a Reception at the city chambers on the Tuesday.

The various speeches made at each day's functions were each apt to the occasion, often amusing and all good to hear. But we hopewe will be excused for remarking that nothing of particular importance was said, nothing that calls urgently for a report in these pages. What was said was intended for the ears of those present, not addressed to engineers at large as it had to be the year before. But an exception must be made in favour of the two technical papers presented during the meeting and of the discussions that followed. Both were of abiding interest and if we choose to comment more fully upon

Mr. Crowe's, entitled "Some Recent Advances in Mechanical Engineering on Shipboard," rather than upon Mr. Fulton's on "Export Vehicle Design," it is only because the former has obviously an appeal to a wider group of engineers than the latter. Mr. Crowe's paper, which we have already printed in abstract, is, as readers will have seen, an example of the type of paper which reviews the past to show what advances have been made up to the present. Such papers always have the immediate interest of a "success" story. For, inevitably, even over a period as short as the twenty-five years covered by the paper, there must be some progress and all progress appears successful. But there is, of course, more to the matter than just a complacent feeling of satisfaction in "something attempted, something done" to be derived from perusing the paper. What rather forcibly strikes the reader is the extent of the progress over so short a period. For there has in the last twenty years been no revolutionary change. The machinery of the old "Duchess of Bedford" and that of the new "Caronia" is essentially similar. Yet, though, indeed, there is little improvement in economy there is a very significant reduction in total weight per shaft horsepower and in space taken up by machinery. The fact is that week by week and year by year engineers introduce small improvements in this detail and in that. But it is not fully appreciated until such a paper as Crowe's emphasises the point how extensive an advance is possible through the mere accretion of small, individual improvements.

Glasgow was the venue for the very first Summer Meeting held by the Institution. That meeting took place as long ago as 1856 and, counting that which has just concluded six more have since been held there. It is none too many. For Glasgow is exceptionally rich in engineering interest. It was from its foundation in the fifteenth century a centre of learning and in this later age it has earned an enviable reputation for the quality of its technical training. Its university was the first in these islands to grant an engineering degree. Besides Rankine, the first great engineering professor, the city nurtured such men as James Watt, Robert Napier, and John Elder. With its rows of shipyards lining the Clyde it is indissolubly connected in the minds of engineers with the building of ships and their equipment. But its factories make very much else as well. Amongst the works visited by members of the Institution were those making such things as turbines and engines, motor lorries, coal-cutting machinery, boilers, ropes, iron and steel products, textiles, pumps and hydraulic machinery vacuum cleaners, sugar machinery, machine tools, sewing machines, pottery, refrigerating machinery, carpets, ventilating plant and refined sugar. Nor does such a list even half suggest the variety of Glasgow's products. The last occasion on which the Institution held its Summer Meeting in Glasgow was twenty-three years ago. But such a city, even allowing for the competition in interest of other areas in these highly industrialised islands is not one that should be visited merely once in a generation. The members of the Institution will hope that not so long a period will elapse before they again enjoy Scots' hospitality at Glasgow.

Obituary

H. A. HARTLEY

We have learned with deep regret of the death of Mr. Herbert Anderson Hartley, which occurred on June 18th at his home, "Edgehill," Stone Lodge Lane, Ipswich, following a serious operation. Mr. Hartley had quite recently been appointed chairman of Reavell and Co., Ltd., in succession to Sir William Reavell, who died on April 25th.

Herbert Anderson Hartley, who was the fourth son of the late Rev. Marshall Hartley, was born on November 18, 1876, and was educated at Bolton Grammar School and Manor House School, Clapham. On leaving school, he worked for a year in the drawing-office of Mr. James Weir, a consulting engineer in Westminster, and then from 1893 to 1897 served an apprenticeship with Tannett Walker and Co., Ltd., of Leeds. During the years of his apprenticeship he also took a course of instruction at the Yorkshire College, which is now part of Leeds University. Upon the completion of his apprenticeship Hartley went to Germany for the special purpose of studying limit gauges at the Berlin works of Ludwig-Loewe, and on his return to England he worked for some months as assistant to the late Mr. Houston Stewart, M.I.C.E. In 1899 Mr. Hartley joined the staff of Ruston Proctor, Ltd. (now Ruston and Hornsby, Ltd.), at Lincoln, as assistant to the works manager, and in 1903 he went to Ipswich to become works manager of Reavell and Co., Ltd. For the last forty-five years, therefore, he had been actively engaged in the affairs of that company. He was appointed to the board of directors in 1908.

Mr. Hartley was elected an associate member of the Institution of Mechanical Engineers in 1903, and was transferred to full membership in 1921. In 1932 he became a member of the Institution of Production Engineers, was chairman of its council for two and a half years, and was subsequently elected a Vice-President. For some years Mr. Hartley served on the Mechanical Industries Committee of the British Standards Institution, and, until last year, was chairman of the Standards Committee of the Institution of Production Engineers. In recognition of his work in that connection, he had recently been made an honorary life member of the Institution of Production Engineers.

In addition to all these activities Mr. Hartley found time to participate in the work of several educational and religious organisations in and around Ipswich. At the works he took a particular interest in personnel and welfare matters, and his death so soon after becoming head of the firm which he had served for forty-five years will be keenly felt not only by colleagues and employees, but by his many friends in this country and abroad.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

PRODUCTION PER MAN HOUR

Sir,—Your Leader and Mr. B. H. Dyson's article (The Engineer, June 18, 1948) are valuable contributions to this subject; but I would suggest that no discussion of P.M.H. can be adequate if it ignores a recent publication by Lewis C. Ord, called "Politics and Poverty" (Mayflower Publishing Company, London, 8s. 6d.).

Mr. Ord would appear to have certain personal preferences and prejudices which might reasonably be a matter of argument; but his main thesis is so simple and is supported by so much sound evidence that I think we shall neglect it at our peril. Briefly, he asserts that we in England, and even more so in Europe as a whole, have far too many people employed in control and far too few in production; and he blames for this situation not only the Socialists and Government bureaucracy but also the Conservatives and the Industrial hierarchy.

Mr. Dyson mentions that only 40 to 60 per cent of employees are on the production floor and suggests that the P.M.H. or efficiency of the remainder deserves attention. Mr. Ord claims that half the work that non-producers do is unnecessary and that if we paid a good deal more attention to production and a good deal less to centralisation and control we could get 70 to 80 per cent on the production floor, with advantage to everybody.

It has been alleged that the Treasury is apt to spend a pound in order to control the expenditure of a penny. I think it would be fair to say that, in Mr. Ord's view, we are far too inclined to spend manhours on control and statistics aimed at improving production instead of on the productive process itself, and that the net result is a heavy loss in production efficiency. If ten men, often not closely familiar with production conditions, are empoyed to "improve" the production of ninety producers, it is necessary that they should continuously maintain as a result of their work an "improvement" of some 10 per cent; otherwise greater overall efficiency would result if the ten were directly employed in production at the unimproved rate. In practice the producers and the unavoidable minimum of production staff could do quite a lot of the improvement themselves if they were given enough freedom and encouragement and a bit of real, fair competition and advice. Far too often, according to Ord, we enmesh ourselves in a web of statistics and wonderful theories (of which Socialism is only one) which stultify initiative and prevent us from seeing the true road to our objective.

H. G. P. Taylor

Shoreham-by-Sea, June 21, 1948.

THE ENGINEERS' GUILD

Sir,—Mr. A. W. Field, in a letter published in your issue of June 11, 1948, appears to agree that four immediate objectives stated by the Engineers' Guild in a memorandum sent out to professional engineers, are desirable; but he thinks that the formation and activity of the Guild are not the right way to attain those objectives.

He believes that the right way would be for engineers to qualify by enterprise and free competition, and by the study of men and management; and he imagines that the Guild is somehow inimical to this method. He is, of course, mistaken.

The Guild memorandum from which he quotes goes on to say: "It will be for members of the Guild to decide the shape of the Guild's future activities." There is no reason at all why Mr. Field should not, as a member of the Guild, persuade that body, if and so far as it needs persuasion, to adopt his views. In his letter to you he has told us what, in his opinion, engineers ought to do. As a member of the Guild he might be persuading them actually to do it. He thinks that the trend in education is likely to produce more narrow specialists which he regards as a bad thing. A strong Guild, if persuaded that Mr. Field is right might have some influence in getting that trend corrected. Surely, as an engineer, Mr. Field would prefer to be getting something done, and does not really prefer to be a voice in a wilderness.

As to his use of the words "trade union,"

I am not going to argue with him, but just to tell him again that the Guild is not a trade union.

W. A. M. ALLAN

Westminster, London, S.W.1., June 21, 1948.

EXPORT OF MACHINE TOOLS

SIR,—As one of those privileged to hear Sir Peter Bennett's address to the members of the Machine Tool Trades Association, may I correct the wrong impression that Mr. C. F. Brook's letter in your columns (THE ENGINEER, June 18th) may give.

In Sir Peter's speech he repeatedly urged the need for re-equipping British industry with machine tools for, as he said, manufacturers were fighting to get export business and were starving themselves of productive plant in the process, and although that might not be a bad thing for the human body, it is not good for industry. The aspect stressed by Mr. Brook was mentioned by Sir Peter only as a minor point. Mr. Brook's argument may be sound, so far as it goes, but it ignores the far more important point which Sir Peter stressed.

R. WHIBLEY, A.M.I. Mech. E.

Wilmslow, Cheshire, June 22nd.

TRAIN SERVICE COMPARISONS: HIGH-SPEED STEAM LOCOMOTIVES

SIR,—Mr. Livesay's belief, expressed in his most interesting article in your issue last week, that "an engine could be built, and run over existing British lines that would be capable of taking a 600-ton train single-handed from London to Edinburgh or Glasgow at an average speed of 60 m.p.h., making at least half-a-dozen stops en route, and without exceeding a maximum of 90," raises some considerations which perhaps contain elements of controversy. May I, as one who has travelled many thousands of miles on main-line locomotives, including a number of journeys between London and Glasgow, offer some entirely independent and objective comments, which may be of interest to many of your readers.

The comparative reference to the speed o the Canadian "International Limited" suggested to me that Mr. Livesay may visualise the average speed of 60 m.p.h. as overall, i.e., including stops. If so, allowing only a total of ten minutes' standing time for "at least half-a-dozen stops," the average running speed is increased from 60 to 61½ m.p.h. The pre-war "Coronation Scot" trains, for which the L.M.S. "Pacifics" were originally built, were allowed 6½ hours for the non-stop runs between London and Glasgow. Six added intermediate stops would, I submit, make an average speed of 60 m.p.h. from London to Glasgow, excluding the six stops, rather more difficult to achieve than the 6½ hours' non-stop timing of the "Coronation Scot," other circumstances being the same; whilst an average speed of 60 m.p.h., including six stops, equivalent to at least 61½ m.p.h. average running speed, would be far more difficult.

The total weight of the pre-war "Coronation Scot" trains, fully loaded, was less than half the 600 tons Mr. Livesay specifies, but he visualises a locomotive only "half again as powerful as the L.M.S. 'Princess Coronations.'" Excellent as these L.M.S. "Pacifics" undoubtedly are, it seems somewhat over-optimistic to assume that a new locomotive, of proportionately equivalent performance characteristics, but only "50 per cent more powerful" could maintain a more difficult timing with loads some 120 per cent greater. Three hundred tons, probably, would about "fill the bill" for the existing engines, and twice that load would require almost double their power. Even though British axle-loading restrictions might permit a 4–6–4 : 4–6–4 "Garratt" locomotive equivalent to two L.M.S. "Pacifics," it would be difficult to provide the necessary boiler power within British loading-gauge restrictions, for increasing length increases reductions due to versed sine on curves: and for long distance express service such as this, steaming capacity is essential. The preceding sentence presupposes that the proposed new locomotive would operate at the same boiler pressure as the L.M.S. "Pacifics," viz., 250 lb per square inch. It would possibly be easier, and less costly overall, to secure the requisite power by means of a substantial increase in boiler pressure. At 350 lb per square inch, a pressure not uncommon in America, a 4–6–2 : 2–6–4 "Garratt" would be an answer, probably the only practicable answer, to Mr. Livesay's belief.

However, it would seem an open question whether a sound case exists for such a train as Mr. Livesay suggests. Although some trains to Glasgow during the war approached 600 tons, the actual average speeds then were often nearer to 40 than to 50 miles an hour. British railways and their traffic, being what they are, it may be better passenger policy and more economical overall to operate two lighter trains, one non-stop at higher speed, and the other to cover intermediate stations, instead of one "combined" 600-ton train with a new super-locomotive. It will, of course, be necessary to make-up all wartime and post-war arrears in maintenance first.

If the principal desideratum is the apparently reasonable one of reducing the overall journey times from London to Glasgow and Edinburgh to minima, the logical course would be to reduce or eliminate intermediate stops, reduce train weights, and increase the ratio of tractive power to total weight; at the same time also reducing permanent way restrictions on speeds as far as possible. In this latter connection, a very large amount of work was done on the L.M.S. main line before the "Coronation Scot" trains were introduced; and further improvements, such, for example, as the elimination of the curves restricting speeds at Stafford and Preston, could be made only at relatively enormous expense, which could hardly be justified. Apart from any indirect prestige benefits to be derived from the operation of special high-speed trains, there would appear to be but little scope for economic gain by reducing the London-Glasgow and London-Edinburgh train times below the best pre-war schedules, now that air transport can reduce the overall journey time to less than half that of the best trains.

Nevertheless, perhaps it may be interesting to venture, in conclusion, a private speculation as to what might now be possible with steam traction, in the light of research and progress during the last decade. It would appear to be practicable to build special light-weight trains, providing modern accommodation for 250 passengers with restaurant service, to a total weight of about 160 tons, empty, or between 180 and 190 tons fully loaded. To operate these trains at the maximum speeds permissible on the existing British main lines, when fully restored, to their pre-war condition, approximate preliminary calculations suggest new steam locomotives of generally conventional design in detail, and the following dimensions: "Atlantic" or 4–4–2 type, coupled wheels 6ft 8in diameter, four cylinders 14in diameter by 24in stroke, boiler pressure 250 lb per square inch, grate area 48 square feet, total weight about 85 tons, of which 45 tons would be on the coupled axles. All four cylinders would drive the leading coupled axle, with connecting rods 7ft long. In brief, the essential characteristics of these locomotives would be stability and low dynamic increments in wheel-loading at high speeds, free-running at 100 m.p.h., wherever permissible, and adequate steaming capacity to maintain 80 m.p.h. up all normal adverse gradients, with the proposed special light-weight trains. They should be capable of maintaining regular services to Glasgow in a little over and to Edinburgh in a little less than six hours, from Euston and King's Cross, respectively. In passing, it may be noted, with regret, that in the past no British railway has ever had an "Atlantic" type locomotive with anything like the grate area and firebox capacity that this type readily permits.

High-speed passenger trains and locomotives always will be one of the most interesting topics of discussion in the whole field of railway operation, but there is far greater economic scope in dealing with the quantitatively far more important goods traffic and suburban passenger traffic. If nationalisation produces a spirit of rationalisation, doubtless these will gain prior attention.

R. OPIE, B.Sc., M.I.C.E., M.I. Mech. E.

London, June 21st.

North of Scotland Hydro-Electric Board's Lawers Project

THE North of Scotland Hydro-Electric Board has published its Lawers project (Constructional Scheme No. 18), which will utilise for hydro-electric generation an area including Ben Lawers and adjacent peaks in Perthshire. The area concerned though small is of considerable value because of its altitude and heavy rainfall. The scheme will produce 71,000,000kWh in a year of average rainfall, and will not only make a contribution towards

LAWERS HYDRO-ELECTRIC PROJECT

local electricity requirements but also to the growing needs of the southern part of the Board's area. It will also supplement the energy available for transmission to the Central Scotland grid. At present prices the scheme is estimated to cost £2,850,000. It will form part of a group of projects in the same district.

As indicated in the accompanying map, it is proposed to tap the waters of various streams draining the slopes of Ben Lawers and lead them to a reservoir, an enlargement of Lochan na Lairige, on the high pass between Killin and Glen Lyon. The collection of the water is to be done at elevations from 1720ft to 1850ft above sea level. To form the reservoir, a gravity dam 1250ft long and 130ft high will be built across Allt A'Mhoirneas, about 470 yards from the outlet of Lochan na Lairige. The Lochan, when raised in level to 1715ft above sea-level, will have storage capacity of 2900 million gallons. When at its new top level there will be a usable fall between Lochan na Lairige and Loch Tay of 1362ft. The impounded water will be taken by pressure tunnel and pipeline to a 30,000-kW capacity generating station, to be built near Finlarig.

A 30,000-kW Pelton water turbo-alternator will be installed in the power station near Finlarig. For the purpose of manning and control this station will form one of a group of five stations and will be remotely controlled from a control centre, an attractively designed building in Killin. The village, which has a population of 423, will be the centre of housing for the Board's staff operating these stations.

Gas Turbine Propelled M.G.B. "2009"

SOME further information about the gas turbine propelled M.G.B. "2009" has now been made available through the issue by the Admiralty of certain material under the signature of A. T. G. Coleburn, of the engineer-in-chief's department. We print the bulk of this material below. We also reproduce again a full-page drawing of the gas turbine installation which originally appeared amongst other drawings printed when we published a full illustrated account of M.G.B. "2009" in our issues of September 5th, 12th and 19th of last year.

The problem of fitting the Metropolitan-Vickers gas turbine in a naval vessel was given to the newly-formed I.C.E. Installation Section of the Engineer-in-Chief's Department in January, 1946. No priority whatever was accorded to the work of installation but by avoiding contractual and official delays as far as possible, M.G.B. "2009" carried out successful trials at sea in August, 1947, thus being the first naval vessel to be propelled at sea by a gas turbine. She was demonstrated to representatives of British, Dominion, and foreign navies, and all sections of the press, in late August and early September, 1947. Interest varied, but all agreed that the installation was an outstanding success. It is worth noting that "Turbinia," the first vessel propelled by a steam turbine, did her trials in the Solent fifty years before—she was 100ft long, 9ft beam, 44 tons displacement, with 2100 estimated h.p., giving a speed of 34 knots. M.G.B. "2009" is 116ft long, 20ft beam, 100 tons' displacement, 4050 estimated h.p., also giving a speed of 34 knots; existing propellers will not allow the engines to develop more power.

The idea of using a marine propulsion unit based on the aircraft type of gas generator was first discussed between the Metropolitan-Vickers Electrical Company, Ltd., and the Engineer-in-Chief in July, 1942. A contract for the construction of three complete units was placed with the firm in August, 1943, permission being obtained from the Ministry of Aircraft Production to use gas generators from those under construction by the firm for aircraft. The development was carried out by the firm in conjunction with the Admiralty Engineering Laboratory and the Department of the Engineer-in-Chief. For convenient reference the unit was given the name of "Gatric."

Arrangements made prior to the conclusion of hostilities were subject to alteration when the war ended and it was in February of 1946 that approval was given to use M.G.B. "2009" and to place a contract for the installation of "Gatric" in her. M.G.B. "2009," built by Messrs. Camper and Nicholson, was then for disposal; she was a boat which had been laid up for some time, but had done very little service. She was engined with three Packards on a three-shaft arrangement; her engine-room was large and "Gatric" could be fitted in place of the centre engine without moving the existing wing engines. It seemed logical therefore to use this boat for the installation of "Gatric" and to let her builders carry out the work.

By May, 1946, the order had been placed with Messrs. Camper and Nicholson, the boat had been inspected by representatives of the Admiralty departments concerned, representatives of the Metropolitan-Vickers Electrical Company, Ltd., had visited the boat-builder's works, and a statement of machinery requirements issued. The Director of Naval Construction agreed to prepare all the guidance drawings, and an advance copy of the general arrangement was sent to the firm in May, 1946. It was decided that Packard engines, as originally fitted to the wing shafts, should be used in conjunction with "Gatric."

A local arrangement was made whereby the overseeing of the re-engining should be undertaken by the Southampton District Overseer.

Fire Risk

The use of Packard engines in conjunction with "Gatric," necessitating the use of petrol, is open to criticism. It must be agreed that this arrangement is most undesirable, observing that the "Gatric" casing in the vicinity of the combustion chamber gets very hot, the electrical units required are not fully flame-proofed, and there is a fuel drain from the combustion chamber which may be ignited. No information was available (at the design stage) regarding the torque produced by "Gatric" at low shaft revolutions; it was generally accepted as being most unlikely that the unit alone would start the boat from rest. It was, therefore, considered necessary to use wing engines of sufficient power to drive the boat up to a speed of at least 16 knots, and further to use engines of known reliability and performance so that the running of "Gatric" would not be prejudiced by the failure of the associated machinery. Also "Gatric" was not provided with a reverse gear and manoeuvring of the boat without cruising engines would have been very limited. No reliable diesels of high power were available for use as cruising engines without considerable expense. The selection of the Packard engines, although undesirable, was therefore a logical step, especially as engines of this type were already fitted in the boat and alteration of existing bearers for the wing engines would not be necessary. To minimise the fire risk attendant on the use of high octane fuel, the following precautions were taken:—

(1) Careful attention to the ventilation of the engine and control rooms, particularly in respect of the fitting of exhaust fans, with ducting, to clear the bilges of petrol vapour before starting up in accordance with normal Coastal Force practice.

(2) Fitting of an airtight casing round the "Gatric" compressor, power turbine, and uptake with a 12½in fan to supply air to the forward end of this casing, which is connected to the space between the extension of the exhaust duct and the inner funnel, so that the air flow through the casing is encouraged by the ejector effect of the exhaust gases.

(3) Installation of methyl bromide fire extinguishing equipment, with jets at all possible sources of fire, and controls on the bridge and at the control room hatches. Jets are provided in the settling space; it has been questioned whether operation of this part of the equipment, injecting the methyl bromide direct into the intake of the gas generator would, in fact, stop the "Gatric." This has not yet been tried.

Preparation of the Boat

It was indicated by the Director of Dockyards that in view of the drastic cut in the dockyard estimates, the expenditure on M.G.B. "2009" must be kept to a minimum. The actual cost of installation was very small when compared with the cost of the development of "Gatric." However, in order not to prejudice the running of the gas turbine, it was decided to remove the whole of the existing machinery for overhaul or renewal. Wing main engines were replaced by two Packards of the latest type (W.14), each capable of developing 1300 h.p. at 2400 r.p.m. and the associated installation equipment was brought into line with latest practice, using, wherever possible, existing piping and accessories after cleaning, examination, and test. The existing Wilson 3 : 1 reduction gearboxes on the wing shafts were returned to the makers for overhaul and replaced in the boat. Two Morris Mawdsley 12½-kW generating sets supplied from Admiralty stocks were fitted, one on either side of the engine-room at the after end. The existing Marston flexible fuel tanks were removed and those required for replacement returned to the manufacturers for modification, repair, and test. Only two of the three tanks removed from the forward tank space were replaced, and these provide stowage for 1830 gallons of fuel (Pool gas oil) for the gas turbine. The space vacated by the remaining tank has been converted into a "settling space," the purpose of which is referred to later. The tanks removed from the after tank space were re-sited further aft and provide stowage for 1754 gallons of 100 octane petrol for the Packards and 277 gallons of Pool petrol for the auxiliary engines. The after tank space has been utilised as a machinery control room. Modified Lockheed Mark VI power-operated steering gear, embodying a self-bleeding system, has been fitted for experimental purposes. Equipment in the engine-room, has, of course, been re-sited as necessary and new wing propellers fitted to dimensions designed to suit the revised performance of the boat, viz., 44in diameter by 63in pitch by 815 square inches developed blade area.

Fitting of Unit

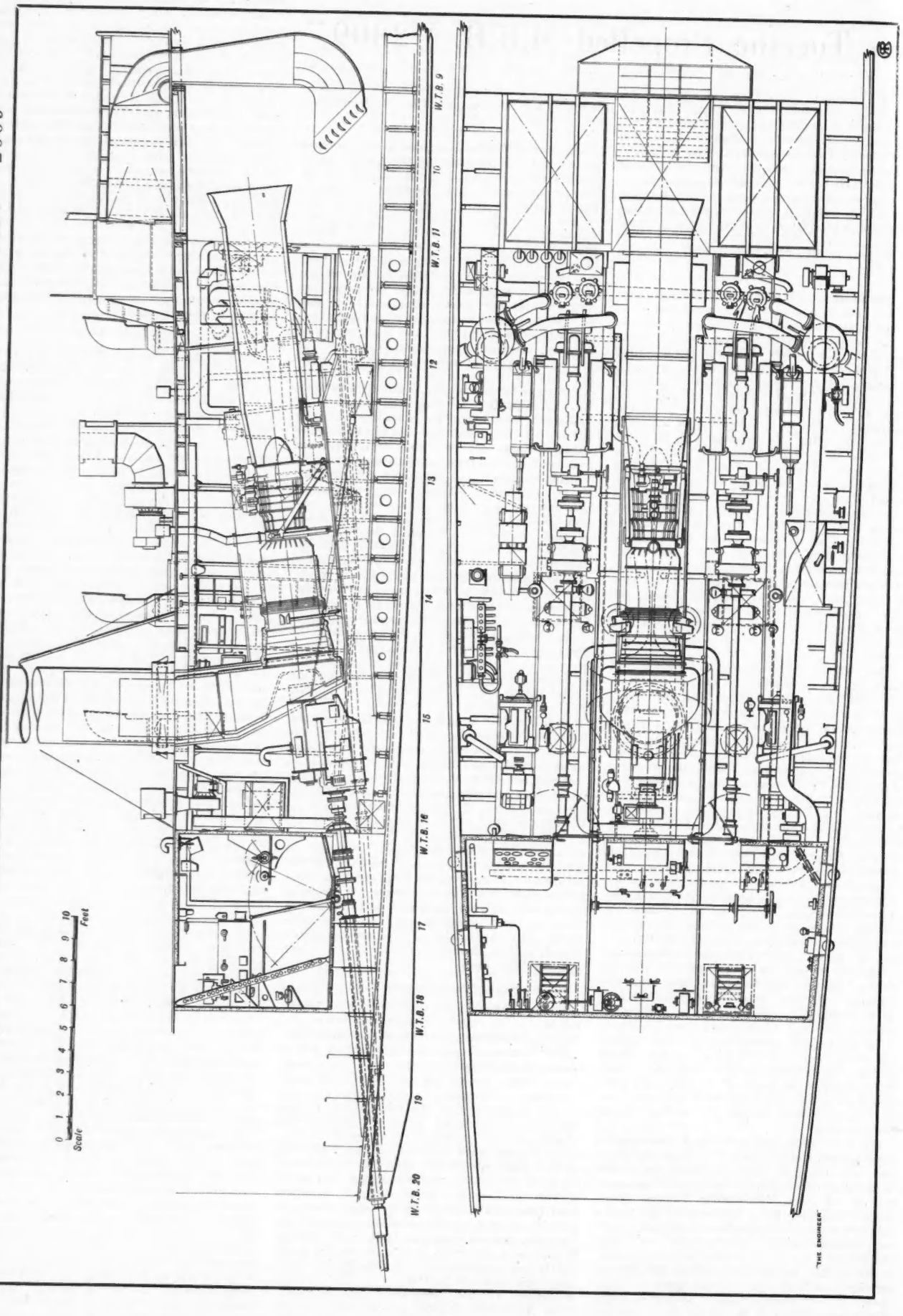
The "Gatric" is installed on the centre line of the vessel with the gearbox output coupling about 18in forward of the engine-room aft bulkhead. Prior to the installation of the actual unit a full-scale wooden mock-up, built by Messrs. Metropolitan-Vickers, was fitted in the boat to determine whether the position selected was the best possible.

After the propeller bracket, stern tube, and bulkhead gland had been lined up and the shafting fitted, the gearbox was presented to the propeller shaft coupling and lined up with it. The longitudinal position allowed for the float of the shaft between the ahead and astern pads of the thrust block. The gearbox top cover was then removed to obtain access to the turbine coupling and the quill shaft alignment collar and the power turbine, complete with its exhaust branch and forward supporting frame, bolted to the gearbox; the position of the supporting frame being adjusted with the aid of the jacking screws provided, until the turbine and pinion shafts were aligned. The next operation was to lower the gas generator, complete with its supporting frame, on to the bearers and slide it aft up to the power turbine. The axial position of the gas generator is dictated by the necessary cold clearances to be maintained internally and it has also to be co-axial with the power turbine in order to avoid unnecessary stress on the bellows type expansion join between the two units. The position of the supporting frame was adjusted to meet these requirements. After the position of each unit was determined, packing pieces were fitted under the feet, holding down and coupling bolt-holes reamered and bolts fitted.

Stern Gear

New shafting, stern tube and bracket to suit the designed horsepower of "Gatric," i.e., 2500 h.p. at 1087 shaft r.p.m., are fitted. This equipment is, of necessity, larger than that fitted for the original Packard engines, which developed 1250 h.p. at 800 shaft r.p.m. To facilitate the fitting of "Gatric" the shaft angle was increased from 6 deg. to 7½ deg. The shafting is of Staybrite F.D.P. stainless steel, 4in diameter, this material being selected because of the early delivery promised. After some delay at the forgemaster's it was decided to machine the shafting in Portsmouth Dockyard. Considerable difficulty was experienced in the machining operation and it was found necessary to "rest" the propeller shaft after each "cut," since it distorted immediately after the "cut," but returned to straight when "rested." A short intermediate shaft about 3ft 6in in length is included in the shaft line between the gearbox and propeller shaft. This was given a special ground finish to a tolerance of $\pm 0{\cdot}015$in and sent to the Admiralty Engineering Laboratory to enable a Maihak torquemeter to be fitted and calibrated, it being specially desired to measure the shaft horsepower of "Gatric" under sea conditions. Despite the almost perfect conditions in the boat, however, it has been found that the

MACHINERY ARRANGEMENT OF GAS TURBINE PROPELLED M.G.B. "2009"



Maihak, an instrument of German manufacture, would not function during preliminary trials, owing, primarily, to the poor components of which the equipment is formed.

The bracket and propeller were manufactured in manganese bronze, since considerable delay would have been occasioned if nickel aluminium bronze was insisted upon. The original underwater fittings pertaining to the Packards were made of the latter material and any slight interaction between the different metals was acceptable in order to avoid delay in delivery of the equipment.

Consideration was given to the fitting of controllable pitch reversing propellers but this was abandoned in view of the time and cost involved in their design and production. At the time of ordering the fixed pitch propellers it was considered unlikely that "Gatric" would reach the designed power of 2500 h.p. and the centre propeller was designed therefore for 1800 h.p. only, this being a conservative estimate of the possible power. Particulars of the centre propeller are: 44in diameter, 46in pitch, 1220 square inch developed area, 0·039 blade thickness ratio, and three blades of segmental section with washback at the root. Tolerances are in accordance with Admiralty requirements for the propellers of high-speed Coastal Force craft.

Rubber "Cutless" bearings of fluted type are fitted to the wing shafts. Similar bearings fitted to the centre shaft failed after the initial run due to lack of water supply and were replaced by Burns plastic bearings of linen/resin type.

Fuel System

The gas turbine plant is fitted with a Plessey fuel pump and K.D.G. fuel filter. In order to provide a positive head at the pump inlet, a Pulsometer 220V electrically-driven booster pump type FB.15 is fitted in the fuel supply line and can take its suction from either tank. As a non flameproof motor had to be accepted to avoid a late delivery, the complete unit was fitted inside the "Gatric" casing. The pump, which is centrifugal type, has a discharge of 360 gallons per hour, against a head of 7 lb per square inch at 5600 r.p.m. and can, if necessary, be primed by a hand pump.

An Avery Hardoll direct reading flowmeter is fitted in the fuel supply line in the control room. An accuracy of $\pm 0 \cdot 1$ per cent for readings over one gallon per minute is claimed by the makers for this instrument, which is of the ordinary garage type. Incidentally, a similar meter is fitted in the Packard fuel supply line, but this instrument has given trouble, due to the suction of the Packard fuel pumps being insufficient to draw the liquid through the long fuel lines in addition to the meter. Arrangements are made for fuel transfer priming and defuelling by a hand-operated pump. All fuel for the gas turbine is filtered through a Vokes E77 portable slave filter, loaned by the makers, before being pumped into the ship's tanks. Fuel to the engine is passed through a Vokes Type E55F filter with a felt element giving a filtration of 5 microns (equal to 0·002in).

Lubricating Oil System

The metering pump supplying oil to the gas generator and power turbine bearings is gravity fed from a 10 gallon oil tank fitted under the deck head.

The "Gatric" gearbox, designed and manufactured before the question of fitting the unit in a Coastal Force craft was considered, was intended for use with a drain tank of 40 gallons' capacity fitted underneath the gearbox, but this fact was not fully appreciated until after the propeller shaft line had been fixed. The gearbox is fitted with a Rotoplunge pressure pump, 1200 gallons per hour capacity, driven off the input shaft. The feasibility of fitting a scavenge pump inside or outside the gearbox driven from the gear shafts was fully explored, as also was the possibility of fitting several interconnected drain tanks to a total capacity of 40 gallons in the narrow confines of the bilges beneath, or in the vicinity of the gearbox. Such efforts were abortive, however, and a system embodying a small drain tank of 9 gallons effective capacity with a scavenge pump and oil storage tank was adopted. The scavenge pump is a 1½in Parsons industrial type of 2500 gallons per hour capacity, belt-driven from the propeller shaft at 750 r.p.m. This arrangement has proved quite successful. A semi-rotary pump is fitted so that the gearbox sump and drain tank can be emptied when the "Gatric" is stopped. Supply of salt water to the gearbox oil cooler is provided by scoop.

Air Casing and Lagging

The fitting of an air casing round the whole of the "Gatric" unit, excluding the gearbox, was decided upon to avoid the risk of fire consequent upon the impingement of petrol vapour on the hot surfaces of "Gatric." It was known that during bench tests certain parts of the engine glowed red, and it was impossible adequately to cover these parts with lagging. The casing is constructed of light sheet steel and steel angles, the edges of the plates being bedded down on rubber strips to ensure airtightness.

Pipes and controls passing through the casing are fitted with solid flanges or packed glands. In general, the air space is not less than 4in and is connected to the uptake as already described.

Over those components which require attention when the unit is in use, portable panels are fitted. The whole of the casing is removable, but this is a tiresome job, owing to the number of small bolts involved. Air is supplied by a 12½in Admiralty pattern fan through a French head vent to the forward end of the casing, and is exhausted to the uptake. The casing was tested to an internal air pressure of 3in of water, the outlet annulus being sealed by an ordinary motor tyre tube pumped up in position. It was hoped that whilst the "Gatric" was running, the 12½ in fan would maintain a slight positive pressure in the casing, to exclude the possibility of entry of petrol vapour, but the ejection proved to be so great that this was not realised. In order to overcome the depression in the casing and to lower the high temperature in the vicinity of the uptake, two additional cowls were fitted with ducts to the casing at the tops of the volute. This produced the desired effect. The fitting of the casing, although undesirable from the point of view of accessibility for maintenance of the unit, is valuable in reducing the noise and heat in the engine room. The "Gatric" combustion chamber and turbine casings are difficult to cover with plastic lagging owing to the number of projections and the movement by expansion, estimated at ¼in per foot; 1½in asbestos mattresses are therefore fitted over these parts. The volute is covered with 2in of plastic lagging. It is observed that asbestos mattresses have a limiting temperature of 800 deg. Fah., and the temperature of the casing varies between 900 deg. to 1500 deg. Fah. Periodical inspection of the mattresses will, therefore, be carried out to determine whether they are scorching or deteriorating. Such lagging is, of course, insufficient by itself; the original recommendation was a minimum of 2in of magnesia and 2in of Newtempheat to give a surface temperature not exceeding 118 deg. Fah. above the ambient air temperature, a total of 7in being considered desirable for the temperatures involved. The asbestos mattresses, however, in conjunction with the air casing, have proved most effective, the latter being fitted with 1in of magnesia covered by expanded metal and "Bulldog" cement on the inside in way of the turbine, where the radiant heat is a maximum. The casing remains cool and very little heat is transmitted to the engine-room.

Intake Ducting

The problem of getting the large quantity of air required for "Gatric" at full power (about 600 cubic feet per second) into the machine without salt spray, or sea-water in rough weather, is a major one in such a comparatively small craft. Various forms of intake ducting were given consideration, it being borne in mind that any scheme involving a large alteration to the ship's structure was undesirable. Arrangements varied from an intake funnel abaft the bridge to intake ducting through the wheelhouse. The scheme finally adopted makes use of a space underneath the bridge; air is taken in through a 1in wire grille, led down a wooden duct fitted with splitters at the bends and turned downwards into the settling space by wooden vanes fitted in a sheet metal casing. By this means it is hoped that the air will drop most of the globules of water held in suspension and pass on, reasonably free of moisture, through a ¼in wire mesh into the cylindrical duct leading to the compressor inlet. Any projections in the ducting which could not be avoided were carefully faired off and the whole of the ducting was treated internally with Phonoglaze paint, and externally with Porcella fire-resisting paint. The cylindrical duct is 30in diameter by 12ft 4in long, fitted coaxially with the compressor and made of balsa wood strips 2in thick, glued and filleted, the whole being strengthened by metal bands and flanges; a bell-mouthed entry and a tapered portion to the compressor inlet are provided. The duct is free to extend forward through the engine-room bulkhead, which is provided with a watertight rubber gland capable of taking the weight of the forward end of the duct, which, incidentally, weighs 311 lb. It is supported at its after end by the flexible front plate of the air casing and in the middle by tension rods from the deck. The arrangements ensure that no appreciable strain due to expansion, or hull distortion, is transmitted to the unit. No attempt other than the introduction of balsa wood, which has sound absorbent qualities, has been made to "silence the intake." The principal noise is that emanating from the compressor and takes the form of a gradually increasing scream, which is at its loudest when the gas generator rotor speed is about 4000 r.p.m. Action is being taken to study the noise problem and to introduce silencing devices in future designs.

Exhaust Uptake

The outlet of the exhaust volute provided by Messrs. Metropolitan-Vickers is 30in diameter. The temperature of the exhaust gases is approximately 1075 deg. Fah. and the velocity about 340 feet per second. In the circumstances it appeared that a funnel was the only logical solution to conduct the hot gases outboard. A suggestion to utilise the thrust of the exhaust, estimated at 3 per cent of the propeller thrust, was rejected, as speed was not of primary importance. A vertical funnel was decided upon so that it would "provide no clue, in silhouette, to the direction of the boat." The funnel casing is 40in diameter, 9ft high, with an inner funnel 37in diameter, and approximately one-half the height of the outer funnel. Cooling air is drawn through the space between the casings from louvres provided at the base of the stack by the ejector effect of the exhaust gases. The height of the inner funnel proved to be insufficient as the upper part of the outer casing became too hot for ordinary paints. Aluminium paint has been found satisfactory except when seawater is splashed on to the hot surface, when a brown staining appears. An extension to the exhaust volute, 30½in diameter, is fitted up to approximately one-quarter of the height of the outer funnel and air is drawn from the air casing around the "Gatric" unit through the annulus thus formed. The extension to deck level is lagged with asbestos rope to a thickness of 2in. The air through the annuli has a cooling effect on the exhaust gases.

Drains and Vents

All drains depend upon gravity and pipes are arranged with a gradual downward slope towards the drain tanks, which are provided with large vents led to the deck, dipsticks, and pumping out connections to a semi-rotary pump.

The combustion chamber drain, which may have to deal with ignited fuel, is a long, small bore, solid-drawn copper pipe, which is led to a small closed tank sited in the settling space. This drain, jocularly referred to as the "flaming drain," being below the waterline, presented a difficulty in the disposal of the ignited fuel in an engine-room where petrol vapour may be present. In the test house it was merely

dropped into a drip tray under the engine. The present arrangement in the boat appears to meet the case, but there remains the remote possibility of ignited fuel exploding fuel vapour already in the drain tank. This should, however, be taken care of by the large vent, which is 9 square inches in area.

The "cold" drains from the journal and thrust bearings and the fuel isolating valve, comprising lubricating oil, air, and fuel, are led to a 20 gallon tank fitted between the "Gatric" bearers underneath the forward end of the machine.

Controls

Inching Motor Starting and Stopping Buttons.—Use of the one-sixteenth h.p. inching motor, which is geared to the gas generator rotor, prevents damage to the ball bearings from vibration during long cruising periods with the "Gatric" unit stopped. Incidentally, the power turbine bearings are protected during such periods by virtue of the trailing of the centre propeller, the oil drag in the gearbox being sufficient to keep the gears and the power turbine rotating slowly. An electrical interlock ensures that the inching motor cannot be started unless the isolator valve lever is in the closed position.

Clutch Operating Wheel.—For starting up and running "Gatric," the wheel is placed in the "engaged" position so that the clutch can engage when power is applied at the turbine coupling. In the "disengaged" position the clutch is positively held out of engagement and the fuel cut-off valve controlled by the oil trip, referred to below prevents the gas generator being started. In either case the propeller shaft, when trailing, is prevented from driving the power turbine.

Hand Priming Pump.—Before attempting to start the unit it is necessary to build up a pressure of approximately 1·5 lb per square inche in the gearbox lubricating oil system by means of the hand priming pump. This is because a spring-loaded low pressure oil trip is provided which cuts off the fuel supply and shuts down the whole unit when the oil pressure in the gearbox falls below a safe value.

Oil Trip Resetting Wheel.—The trip, referred to above and hence the fuel cut-off valve, cannot be reset until the clutch mechanism controlled by the operating wheel is in the "engaged" position.

Full Booster Pump Switch.—The switch controls the electrically-driven fuel-booster pump, referred to earlier which produces a positive head at the engine fuel pump.

Starter Motor Push Button.—This controls a 24-V starter motor geared to the gas generator rotor. It is of insufficient power to revolve the rotor above 800–1000 r.p.m., at which speed lighting up is effected. The power then generated at the gas generator turbine assists the motor to increase the revolutions to about 2000 r.p.m., when the machine becomes self-sustaining. The motor is then switched off by releasing the pressure on the push button. The starter motor circuit is dead unless the trip is reset and the throttle lever is in the idling position.

Ignition Switch.—The ignition is switched on at the same time as the starter motor. A solenoid valve permits fuel to pass from the main fuel pump delivery to igniter jets formed with two electric spark ignition plugs fed by boost cells. An indicating lamp is provided to show when the ignition circuit is closed.

Fuel Isolator Valve Lever.—The fuel isolator valve is opened when the fuel pump is delivering at the fuel relief valve pressure (approx. 560 lb per square inch) and admits fuel to the atomiser jets. Servo-operation automatically permits the gas generator rotor to run up to its idling speed of 3000 r.p.m. Closing the valve will stop the unit, since fuel is shut off and the pressure in the jet rail is released.

Throttle Lever.—The throttle lever actuates the main throttle valve, which regulates the quantity of fuel admitted to the combustion chamber and is the sole control of the power output. The opening of the valve is automatically limited by servo-action to give an acceleration that is as high as possible without stalling the compressor.

Hand Trip Knob.—Depression of the hand trip knob in an emergency will cut off the supply of fuel and stop the plant. It is more convenient during normal operation to use the isolator valve lever.

Instruments.—Instruments are necessary at the control position for registering the following: gas generator and shaft r.p.m., fuel relief valve, fuel jet rail, and gearbox oil pressures, gearbox oil inlet and outlet, thrust-block oil outlet, turbine forward and after bearing, gas generator forward and after bearing temperatures.

The gas generator after bearing was considered to be the only one liable to give trouble by overheating and the thermometer was duplicated. Other instruments required for record purposes are fitted separately on the port side of the control room. As far as possible aircraft pattern instruments are fitted, these being obtained from R.A.F. stocks.

Weights

The weights of the components of the "Gatric" unit are as follows:—

Gas generator	1,660 lb.
Power turbine	2,050 lb.
Gearbox	2,600 lb.
Supporting frame	230 lb.
Lagging	290 lb.
Controls and ancillaries	90 lb.
Total weight	6,920 lb.

Table I has been prepared for comparative purposes with machinery as normally fitted in a large Coastal Force craft.

Table I

Equipment	Total weight (lb.)	Specific weight (lb./h.p.)
"Gatric" as above but excluding gearbox. Designed power = 2,500 h.p.	4,320	1·72
"Gatric," including gearbox	6,920	2·77
"Gatric" installation, excluding fuel tanks	13,500	5·40
Packards, two engines including reverse gears and frame but excluding reduction gearbox Maximum permissible power = 1,300 h.p. per engine	5,840	2·25
Packards, including gearboxes and coupling shafts	7,830	3·01
Packard installation, excluding fuel tanks	18,000	6·92

It will be seen that the gas turbine compares favourably with the reciprocating petrol engine, especially when it is recollected that:—

(1) The Packard is a light-weight marine engine, developed for Coastal Force craft; it is the best marine engine of its type but it is doubtful whether its power could be developed beyond 1500 h.p. without increase in weight.

(2) "Gatric" is the first of its kind, and doubtless in subsequent units power can be substantially increased without proportionate increase in weight.

(3) The existing "Gatric" gearbox could be replaced by one of lightweight design, with a saving of weight of 1000 lb or more.

Advantages

The ultimate advantages expected from the use of gas turbines as compared with the reciprocating internal combustion engine and steam turbine machinery are:—

Reduction in Weight and Space for a Given Horsepower.—The problem of weight has already been discussed.

It is reasonable to suggest that the reduction in space will be more noticeable in installations of greater power.

Gain in Overall Efficiency.—The overall efficiency of "Gatric" is poor, but it was fully appreciated at the outset that the fitting of the aircraft type gas generator as part of the unit would affect the efficiency on account of the low compression ratio of the compressor. This action was justified as it was only by the use of an existing gas generator that experience could be obtained with a complete propulsion unit at an early date. "Gatric" is most economical at approximately full power, when the fuel consumption is 1·06 lb/b.h.p./hour, with a corresponding overall efficiency of 12½ per cent (based on a calorific value of fuel equal to 19,500 B.Th.U./lb). Fuel consumption rises to 3·4 lb/b.h.p./hour at 250 h.p. and efficiency falls to 3·8 per cent. With the use of higher compression ratios, multiple stages in compressors and turbines, intercoolers and reheat chambers, efficiency can be substantially improved and plants are now being designed to that end.

Less Time in Starting Machinery from Cold and Working up to Full Power.—The time taken to start from cold and attain full power in the boat is under a minute and a half.

Less Complication and Vulnerability.—The introduction of equipment to ensure increased efficiency will not contribute towards this point, but the large variety of cycles possible makes the arrangement of components very flexible and the parts can be disposed to give the maximum accessibility and the minimum vulnerability.

Availability of Relatively High Power Units.—The engines available for Coastal Force craft are the Packard (1300 h.p. petrol engine) and the Mercedes Benz (2500 h.p. diesel engine). These are of insufficient power to propel boats of the size, armament and speed which may be required by the Navy of the future.

Use of Low Grades of Fuel and Consequent Reduction of Fire Risk.—This again applies particularly to Coastal Force craft. It is manifestly desirable to avoid the use of high octane petrol in marine craft from the aspects of fire risk and reduced supplies in an emergency. "Gatric" runs on Pool gas oil—future gas turbine plants may well run on low grades of boiler fuel.

Less Maintenance.—It is visualised that maintenance on board between major overhauls will be of a very minor character and limited to the ancillaries. It is of interest to note that during the first fifty hours' running, no maintenance work whatever was carried out on "Gatric."

High Torque.—A feature of the gas turbine plant with a free power turbine is the high torque available at low speeds. This is of particular value when towing, in the event of hull damage or failure of other propelling machinery.

Disadvantages

The present disadvantages are:—

Short Life.—The life of "Gatric," i.e., the time between major overhauls, is as yet unknown. Deposits of dust and salt may affect the performance of the compressor but such fouling could probably be overcome by fitting suitable air filtering arrangements; this is already under investigation. The erosion and creep effects of the hot gases on the turbine blades may be the limiting factors determining the life of this type of propulsion unit. Vigorous investigation into this problem is proceeding.

A possible solution is to accept a reasonable period between major overhauls, when the unit would be lifted out and rebladed. Modern foundry methods make possible the accurate casting of blades, which require no further machining and large stocks of these could be accumulated in preparation for any emergency.

High Fuel Consumption.—The present unit suffers from a very high specific fuel consumption but, as already mentioned, this was known and accepted when designing the unit; the aim of future designs will be to obtain a specific fuel consumption comparable with that of a diesel engine.

Future Programme

A replacement unit capable of the full designed power of 2500 h.p. will be fitted together with new propellers to all three shafts to suit the revised performance of the boat.

Silencing equipment will be fitted to the air intake and the exhaust uptake.

An extensive programme of trials will be carried out with the new unit, probably taking up to the end of 1948. The trials are designed to obtain performance figures of "Gatric" under sea conditions. Periodic opening-up is catered for in order that the life of the unit may be determined.

Iron and Steel Prices

THE Minister of Supply has made the Control of Iron and Steel (No. 64) Order, which came into operation on June 21st. The Order increases the maximum price of pig iron (other than common foundry iron) and semi-finished steel.

The purpose of the Order is to give effect to an offer by the British Iron and Steel Federation, following the Chancellor of the Exchequer's special appeal to industry in respect of prices to absorb part of the abnormally high freight cost on imported ore previously paid from public funds by a contribution amounting to about £2,250,000 a year. This arrangement itself involves no increases in the price of finished steel but only in basic and hematite pig iron, cylinder and refined iron, and semi-finished steel. At the same time minor increases are made on various other grounds in the maximum prices of certain products.

The following is a list of Deposited Schedules lodged under the above Order, together with the corresponding Schedules under the previous Order and an outline of the alterations involved.

New Schedule	Old Schedule	Product	Remarks
—	—	Basic pig iron	Increased by 4s. per ton
106	1	Hematite pig iron	Increased by 6s. per ton
107	5	Staffordshire blast furnace	Increased by 1s. per ton
108	6	Scotch foundry iron	Increased by 4s. per ton basis, delivery extras revised
109	7	Cylinder and refined irons	Increased by 6s. 9d. per ton
110	8	Refined malleable iron	Increased by 6s. 9d. per ton
111	9	Cold blast pig iron	Increased by 1s. per ton
112	10	Blast furnace ferro manganese	Schedule re-edited
113	11	Spiegeleisen	Increased by 34s. per ton
114	13	Billets, blooms and slabs for re-rolling	Increased by 5s. per ton
115	14	Billets, blooms and slabs for forging	Increased by 5s. per ton
116	15	Admiralty blooms	Blooms and slabs increased by 5s. per ton
117	16	Tube steel billets	Increased by 5s. per ton basis, extras for sizes under 3in increased
118	18	Alloy steel	Minor corrections
119	20	Stainless steel	Schedule re-edited
120	21	Shell steel	Billets for re-rolling increased by 5s. per ton; low temperature treatment extra amended
121	22	Tinplate and sheet bars	Increased by 5s. per ton
122	27	Light rails	Extra established for delivery by road
123	28	Colliery arches	
124	29	Pit props	
125	30	Re-rolled products	File steel prices amended
126	46	Gas list screwed and socketed tubes and tubulars	Prices for buttwelded tubes extended to 4in; extras and allowances revised
127	47	Commercial quality H.F. seamless tubes and pipes—gas list sizes	Extras and allowances revised
128	54	Hot finished boiler tubes	Extras and allowances revised
129	71	Cast iron drain pipes	Increased by 30 per cent
130	74	Mild steel wire	Mattress and paper clip wire increased
131	80	Special patented wire	Cutting extras increased
132	86	Wire ropes	Minor adjustments
133	87	Steel forgings	Prices for rolls withdrawn
134	—	Plates 3mm and thicker wholly rolled down in a sheet mill	Establishing prices and extras

National Physical Laboratory's Exhibition

AN exhibition of scientific research work in progress at the National Physical Laboratory, Teddington, Middlesex, was held on June 21st and 22nd, to give visitors from scientific establishments, industrial organisations and universities an up-to-date picture of the activities of the Laboratory. It may be recalled that the main purpose for which the Laboratory was founded in 1900 was to help British industry in the fields of physics, electricity, engineering, metallurgy and ship design. More recently, mathematics, metrology, aerodynamics and radio have been added to its responsibilities. Accordingly the work of the Laboratory is now conducted in ten Divisions, each under the control of a superintendent, and the exhibition was arranged to show examples of current work in these Divisions. In this short article we can deal with only a few of the Divisions, referring briefly to some of the current activities that are comparatively new to the Laboratory.

Engineering

One of the more recent interests of the Engineering Division is photo-elasticity, which gives the engineering designer a useful method of stress analysis. Photo-elastic stress patterns are obtained by making a model of the part to be examined from some transparent plastic, loading it so as to represent the conditions of service and viewing it in polarised light. Contours of equal shear stress appear as the load is applied and these enable the designer to see where regions of high or low stress occur. It is therefore possible to see where strengthening is needed or where low stress permits the part to be reduced in section, and thus in weight.

Visitors to the exhibition saw demonstrations of equipment installed in the Engineering Division for the analysis of plane stress problems, i.e., where all the stresses act in one plane. Three-dimensional stresses can be investigated by the frozen stress method. A recent addition to this equipment is a photo-electric photometer for accurate measurement of the photo-elastic patterns.

Heat transfer by forced convection, with mercury as the working fluid—a subject of considerable practical significance—formed the basis of another exhibit.

Mercury (and the liquid metals generally) are interesting scientifically because of the low value of the rate of transport of momentum compared with the rate of transport of heat within them; work on heat transfer in pipes using mercury as the working fluid was started in 1938, but had to be dropped during the war. Recent developments give prospects of valuable applications in engineering, and the work has been restarted. Basically the apparatus exhibited consisted of an all-steel double-flow heat exchanger with the mercury inside a pipe.

Another exhibit was concerned with investigations into size effect and stress concentration in fatigue. Ever since the discovery of the weakening effect of fluctuating loads on the strength of materials, certain anomalies and discrepancies have been noted. This is due not so much to poor testing technique, but to certain fundamentals, not yet clearly understood. With a cyclical variation in the load applied, the fatigue strength depends not only on the shape and size of the specimen, but also on the type of stressing involved. Both the greatest induced stress and the area over which that greatest stress acts are of importance. The recent acquisition of large machines of German origin has made possible an investigation of "size effect" in fatigue testing.

Extremely damaging effects are often encountered when a change of section occurs; the ratio of the fatigue strengths without and with the change of section—the "stress concentration factor"—may be as high as six. Such effects are being studied over a range of sizes and with various forms of notch. One such notch of great practical importance is the screw thread; the fatigue strength of various forms of screw thread is being investigated with particular reference to the unified thread form proposed for use in the Commonwealth and the U.S.A.

The Laboratory has given considerable help to the aircraft engine industry in the development of bearings for use in gas turbines. Gas turbines run at much higher rotational speeds than piston engines, and special machines running at speeds up to 30,000 r.p.m. have been designed and constructed by the Engineering Division for the testing of ball and roller bearings for use on jet-propelled aircraft.

There is, however, a possibility that, in large gas turbines rotating at high speeds, further developments may involve thrust loadings exceeding those that may conveniently be carried by ball bearings. The Laboratory is therefore investigating the fundamental principles underlying the operation of Michell and plain thrust bearings running under fluid film conditions at high speeds, with the consideration that they may possibly be used to replace ball bearings under very severe operating conditions. A Michell bearing, of 9in outer diameter, was shown running at 10,000 r.p.m. under a thrust load of 10,000 lb.

Air gauging methods are used to measure variations in oil film thickness. Nozzles are mounted on the bearing and are adjusted to within a few thousandths of an inch from a rotating reference ring on the shaft. Movement of the bearing due to changes in the oil film thickness alter the distance between the nozzle orifice and the reference ring, thus changing the back pressure set up in the air feed pipe and this pressure is measured by a pressure gauge. An interesting outcome of preliminary work is the suggestion that oil film pressures arising from centrifugal action may be used to augment the carrying capacity of the bearing.

Aerodynamics

Research on aerodynamics was started at the Laboratory in 1909 and is now carried out in the Aerodynamics Division under the advice of the Aeronautical Research Council appointed by the Minister of Aircraft Production. Over a period of years the Aerodynamics Division has built up facilities for work on fundamental problems at speeds above that of sound. The first continuous-running supersonic tunnel, and the ballistic range were built (by the late Sir Thomas Stanton) about twenty-five years ago.

To-day the importance of aerodynamical research at speeds approaching the velocity of sound hardly needs stressing, but the number of wind tunnels capable of such work is still sadly inadequate in this country and plans for extending such equipment form an important item in the programme of future development. The National Physical Laboratory was a pioneer in the construction of high-speed wind tunnels, and, until very recently, possessed the only tunnels, apart from the large tunnel at Farnborough, capable of fundamental research on a reasonable scale.

For example, recent developments in flying at high altitude combined with high speed have emphasised the need for knowledge of aerofoil performance at high-lift coefficient combined with high Mach number. One of the exhibits was related to measurements made on a number of aerofoil section shapes in the 20in by 8in rectangular high-speed tunnel, from which valuable information has been obtained on the effect of various systematic changes of shape on the point of breakdown of lift at various Mach numbers. We are informed that apparatus is being developed to measure pitching moment over the same range.

Other current researches at subsonic speeds include the beginning of a systematic investigation of the pressure distribution and shock wave pattern for a series of shapes including

one with a hinged flap and another with a local " bump " on the surface.

The importance of transonic-supersonic research is increasing and future tunnels of the induction type will be designed to cover a supersonic range up to at least 15 times the velocity of sound. For supersonic running a square or rectangular working section is essential both for optical purposes and to secure a uniform flow. Visitors to the exhibition were shown the temporary working section, 9½in square, which has been fitted to the original 1ft diameter circular tunnel, and research is in progress to secure a uniform flow at a Mach number of 1·4. We learn that a new small tunnel of 9in by 3in section has been constructed partly for direct supersonic research and partly to serve as a scale model for the development of future projects.

Electricity Division

The Electricity Division consists of three sections which are concerned, respectively, with electrical standards and general electrical measurements, electro-technics, and high-voltage work. As part of its work on standards the Laboratory has charge of the British legal electrical standards—the ampere, the volt and the ohm. These standards are involved in the recent internationally agreed changes, whereby the International units gave place to a system of absolute units expressed in terms of the units of length mass and time.

Part of the work in this Division is concerned with frequency standards for centimetric waves, and one group of exhibits consisted of equipment for extending the range of quartz-controlled oscillations to centimetric wavelengths. By a number of stages of frequency multiplication, mixing and amplification, sources of oscillation are obtained, having frequencies, controlled by the primary standard, of the following values:—33·6 to 36·8 Mc/s in steps of 0·4Mc/s; 67·2 to 73·6Mc/s in steps of 0·8Mc/s and 201·6 to 220·8 Mc/s in steps of 2·4 Mc/s. By using these oscillations and their harmonics up to the order 36, controlled frequencies are obtained throughout the range 350 to 8000 Mc/s at intervals of about 1 per cent. A variable frequency oscillator, monitored by the standard, is used to interpolate between the controlled frequencies without much loss in accuracy. Two further stages are being added to extend the range to 50,000 Mc/s.

The most obvious application of the equipment is the rapid and precise calibration of wavemeters and a demonstration is given of the calibration of a wavemeter in the region of 3000 Mc/s. The sources at their fundamental frequencies will also serve for the testing of cables and dielectrics. An application of more fundamental importance may be the study of the radio frequency spectra of atoms and molecules. The spectra of a number of gases have been examined both in this country and America during the last three years. The spectrum of the ammonia molecule, for example, is found to have lines in the neighbourhood of 23,000 Mc/s and the frequencies of these have been measured to a precision of 1 part in 106 Such lines can be used as standards of frequency and the possibility of obtaining molecular standards of this kind is exciting considerable scientific interest.

Another demonstration showed how measurements of the time variation of the light from sparks could be made by means of a photo-multiplier, amplifier and cathode-ray oscillograph. The immediate purpose of this work is to provide a spark suitable for shadow photography in Aerodynamics Division. The effects on the light from sparks in air of electrode material and spark current are being studied; observations are also being made on a gas discharge tube suitable for light pulses of 1 micro-second duration.

The equipment has been calibrated by a standard tungsten filament lamp and rotating slit. With multiplier output currents below 1mA, and with exposures of the photo cell limited to seconds, it appears practicable to make measurements consistent to better than 5 per cent. The oscillograph deflection is nearly proportional to the illumination and the sensitivity can be conveniently controlled by variation of the voltage applied to the multiplier—over the range of 475V to 600V a change of 50V corresponds to a factor of approximately 2.

In the high-voltage laboratory various demonstrations were given using a power frequency generator capable of producing 1,000,000 volts (R.M.S.). Other exhibits in this section included the flash-over and puncture characteristics of solid and liquid dielectrics under surge voltages, vacuum impregnating, high-speed transient recording, and surge corona phenomena. Visitors were also able to see the progress made in the design and construction of an absolute voltmeter for very high voltages.

Metrology Division

An interesting example of the work of the Metrology Division is an investigation of the fundamental principles of automatic control which is being done with the aim of obtaining basic data on the use of automatic controllers for industrial plants and processes. A pilot plant, using oil circulation, has been built for experimental work allowing the control characteristics of industrial plant to be simulated. In passing through the " control tank " the temperature of the oil is automatically controlled by a closed cycle system which provides corrective action based on the deviation of the temperature from a preselected value. The effectiveness, in the presence of lags of various degrees, of proportional, integral and derivative modes of control employed separately and in combination and also of alternative methods of control will be studied.

For this purpose measurements are made of the transient response of the plant to sudden and sustained disturbances, and the steady state response to sinusoidal variations in the oil flow. The sinusoidal changes are produced by a specially designed harmonic generator operating on a flow valve with a linear characteristic, and a wide range of frequencies can be covered.

North of Scotland Hydro-Electric Board: Annual Report

The North of Scotland Hydro-Electric Board's fourth annual report has recently been published. It describes substantial progress which has been achieved during 1947 in the development of Highland water power and the extension of electricity in the North of Scotland.

By the end of 1947 nine constructional schemes, comprising twelve projects with a total authorised capacity of 439,600kW, had been promoted and nineteen distribution schemes, covering isolated areas totalling 4000 square miles, with a widely distributed population of about 122,250, had been submitted by the Board to the Electricity Commissioners; 320 miles of 132,000V transmission lines, which will connect the generating stations of the north with one another and with the grid in central Scotland, had been surveyed and contracts placed.

The preparation of additional hydro-electric schemes, which will make a large-scale contribution to the country's power resources, made progress during the year and substantial progress was made with the constructional schemes which have received Parliamentary approval. Examination of the potentialities of the undeveloped hydro-electric resources of the Highland area continued. Details of a number of new schemes were considered, and their practicability as sources of future power were proved.

New Schemes

Field surveys on eight new schemes with a total annual potential output of about 820,000,000kWh were completed during 1947. These schemes include the following projects:—

Glascarnoch - Luichart - Torr Achilty (Ross-shire)	60,000kW
Glenmoriston (Inverness-shire)	56,000kW
Glen Garry (Inverness-shire)	40,000kW
Allt-na-Lairigo (Argyll)	5,000kW
Lawers (Perthshire)*	30,000kW
Loch Dubh, Ullapool (Ross-shire)	1,800kW

*Preliminary details of this project appear on page 620.

Contracts to the value of £20,321,948 had been placed by the end of 1947, and as is usual in large-scale civil engineering work, the greater part of the expenditure (about 77 per cent) will be incurred on the site of the works.

The number of workers directly employed in December, 1947, was 4039 (this figure has since increased to 5582). Local men continued to be the first to be employed and it was only when these had been absorbed that recruits were sought from further afield. The construction of camps to house the workmen is given priority in the constructional schemes. Camps to house 8000 people have already been constructed. No group of camps is complete without a cinema, recreation hall, library, hospital, post office and shops. The Board has already incurred an expenditure of over £1,000,000 in the provision of camps and of these amenities.

There have been difficulties to overcome from time to time on the construction work, owing to shortage of materials and of certain classes of skilled labour. The report states that continuous efforts are being made to minimise the delaying effect of these shortages, and it describes what has been accomplished in spite of them in the construction of generating schemes and the extension of distribution networks. Two schemes serving isolated districts in the western Highlands are nearing completion. The plants at Lochalsh, Ross-shire and Morar, Inverness-shire, will be in operation for the winter of 1948.

Scotland is leading the rest of Britain in the commercial application of the gas turbine for the generation of electricity. The Board has made arrangements to install at Carolina Port generating station, Dundee, a 15,000-kW gas turbo-alternator of the closed-cycle type, which will be manufactured at the Clydebank shipyard of John Brown and Co., Ltd. It is hoped that the Dundee gas turbine will be available for service in 1950.

The Board continues to encourage Scottish manufacture of all its requirements of plant and machinery. The most important development in this field during the year was the establishment of a new industry in Clydeside for the manufacture of large hydro-electric plant. Plant is being made for the English Electric Company, Ltd., by Harland and Wolff, Ltd., at Scotstoun, Glasgow; John Brown and Co., Ltd., is making hydraulic machinery; the Harland Engineering Company, Ltd., Alloa, is manufacturing complete hydro-electric plant, and many other Scottish firms are engaged on the production of pipelines, valves and sluice gates, cranes, transformers, generators, switchgear, cableways and transporters.

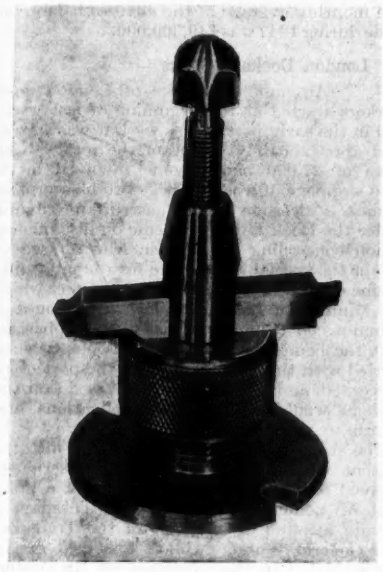
Since 1934, when the Board began to survey and prepare schemes, the costs of machinery and civil engineering works, like everything else, have greatly increased, and the increase continued during 1947. The development of Highland water power remains an economic proposition because the cost of coal has also greatly increased, but, the report states, at the cost of construction in 1947, it will not be possible to produce electricity at pre-war prices.

Latin American Broadcasts.—The extent and scope of the Latin American Service of the British Broadcasting Corporation are not, perhaps, as fully realised as they should be in Great Britain; firm ties developed by common purpose during the war are, it is felt, now being strengthened and widened. Careful study has been devoted to broadcasts of professional and technical interest, particularly in engineering, because of the growing realisation of its wide implications and value in countries still developing vast natural resources and rapidly building up their own industries on a gigantic scale. Many thousands of young men in Latin America are keen engineering students. Mr. Rolt Hammond, A.C.G.I., A.M.I.C.E., has already prepared two series of broadcasts on civil engineering, each consisting of a talk once a week extending over a period of three months. He has now been asked to prepare a third series covering diving in civil engineering; excavating and earth-moving plant; oil tankers; railway rolling stock; marine gas turbines; grain-handling plant; hydro-electric plant; anti-corrosion methods for marine structures; tugs and launches; measurement and recording of vibration; cranes for docks and harbours; trucks for internal works transport; and British locomotive developments.

An Adjustable Tool Post

THE photograph we reproduce below shows a useful tool post which is now being made by Macrome, Ltd., of Aldersley, Wolverhampton. This tool post has been developed to facilitate and speed the correct setting of turning tools relative to the work. The posts are made either with flanges on their bases, as shown, for attachment to a tool slide, or for tee slot clamping.

The tool is set in the slot in the usual way and by screwing the knurled support ring up or down the cutting edge can be accurately positioned in relation to the work. In the tee-slot mounting the column of the post passes right through the screwed portion and has a plate, which fits the tee slot of the machine slide, screwed on its base. As the locking bolt is screwed down, the tool is forced on to the ring, and at the same time the clamping plate is pulled up in the tee slot to hold the assembly rigidly in its working position.



ADJUSTABLE TOOL POST

We are informed that, in addition to making tool posts of this type for a standard range of machines, the makers are prepared to make posts to special dimensions for use on special machines.

Automatic Chromium Plating Barrel

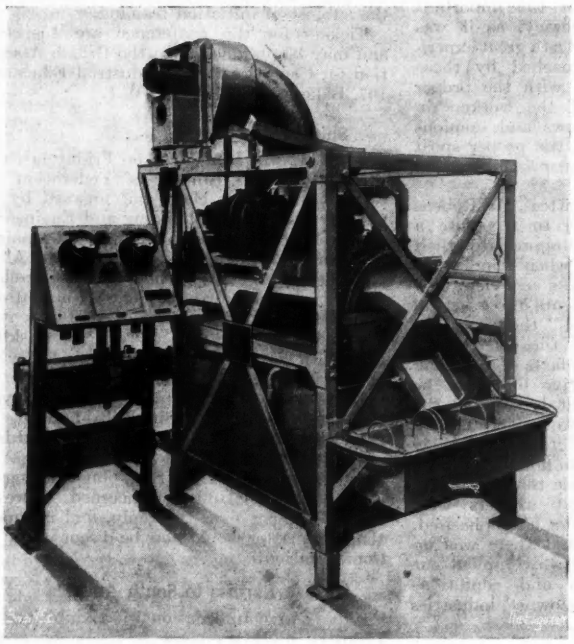
A COMPACT, automatic chromium plating plant has been developed by R. Cruickshank, Ltd., of Camden Street, Birmingham, for the automatic plating of small articles, which have first been nickel-plated.

This plant, which we illustrate herewith, consists essentially of a rigid angle-iron structure enclosing a rotating horizontal barrel partially immersed in a tank containing chromium-plating solution. A screw conveyor of non-conducting material traverses the parts through the plating barrel. The barrel is supported on rollers in a cradle on which is also mounted the driving mechanism. In order that the barrel may be raised above the level of the plating solution when not in use, the cradle is suspended by wire ropes within the framework and it can be raised and lowered by a hand-operated winch.

The barrel and the feed conveyor are driven by a ½ h.p. three-phase electric motor, through a reduction gearbox. A sprocket on a central driving shaft rotates the plating barrel through peg teeth on a plate attached to the discharge end. The barrel is rotated at a speed which gives a plating period of 3½ minutes for all articles passed through.

In operation the articles for plating are automatically fed from a hopper into the barrel by a belt conveyor. This conveyor is driven by a cam and ratchet mechanism from the main drive. Its speed can be varied according to the rate of flow of work required into the barrel.

The metal shell of the barrel and the screw conveyor for the work provides a continuous path for the plating current. Current is passed through two sets of spring-loaded copper brushes making contact with two machined bands surrounding the barrel. A lead anode parallel to the axis of the barrel is suspended from a copper bar supported on insulators from the cradle. The plating tank is of mild steel, lined with antimonial lead and insulated by glass sheets. It rests in an outer tank, which serves as a water jacket for heating and cooling purposes.



AUTOMATIC CHROMIUM PLATING BARREL

At the end of the plating barrel the articles fall into cages in which, as the barrel rotates, they are lifted and drained before being discharged into a chute at the front of the machine.

Ducting on three sides of the plating tank leads to fume exhausting equipment and an adjustable extension of this ducting carries away fumes generated inside the barrel.

South African Engineering Notes

(By our South African Correspondent)

Production of Nickel Silver

Two nickel silver alloys devised in the Mint at Pretoria are now in production at the rate of about 10 tons of sheeting per month. One of them is for the manufacture of articles by the drawing process and the other by the spinning method. This is the first time nickel silver has been made in South Africa and it has been stated that the Mint would have no difficulty in supplying a much larger demand than the present. It is only now that jewellery factories in South Africa are expanding their production and this supply of raw material should do much to stimulate their activity.

Free State Waterworks Scheme

Shortage of labour is slowing down the speed of the construction work at the Free State goldfields water supply scheme, but progress is being made on the laying of the first of four great pipelines which will carry purified Vaal River water from Balkfontein, eight miles from Bothaville, to Odendaalsrust, a distance of fifty-five miles. No dam is required across the Vaal River for the scheme since the site near Kommando Drift, for the pumping station, is adjacent to a rocky cliff on the river's edge and forms a natural reservoir. The waterworks now being built have been placed below the confluence of the Valsch and Vaal Rivers.

To date, 18,900ft of trenches for the first 21in pipeline have been excavated, mainly at Golden Gate, about sixteen miles away, and 12,500ft of the water main have been laid. As far as possible, the pipeline is being laid along the boundaries of farms and not through arable land. It is the intention to pump the river water to great sedimentation tanks and preliminary work has begun on the site of the tanks and the filtration plant. The water is to be pumped to the brow of a hill, whence it will flow by gravitation to Koppie Alleen, near Odendaalsrust, where another pump house will be built. At the Free State goldfields waterworks at Balkfontein, four big storage reservoirs will be constructed, each of an approximate capacity of 1,000,000 gallons. In all, four water mains to Odendaalsrust and Welkom are planned, with smaller subsidiary pipelines from Balkfontein to Bothaville and from Odendaalsrust to Henneman. The total cost is expected to be about £2,000,000 and the scheme will supply not only the Free State gold mines but also a number of municipalities en route.

Njelele Dam

This dam, which has just been recently completed, about 40 miles from Louis Trichardt, commands an irrigable area of 1700 morgen and serves thirty-five riparian farms. It has a capacity of 20,000 acre-feet and forms an impressive sight in its setting among the Zoutpansberg Mountains.

Spillway height was reached last December and the dam was completed at the end of March, at a cost of £135,000. Before the dam was built, considerable irrigation development had taken place along the river, conditions for the production of winter vegetables and fruit being ideal in the neighbourhood. Development resources, however, soon outstripped water resources at the dry period of the year and the new dam was built to meet this deficiency.

The Steel Shortage

It would appear, according to the statements of Mr. B. G. Twycross, president of the Steel and Industries Federation of South Africa, that South Africa cannot look for an increase in steel supplies from local sources until the new steel works at Van der Bijl Park are in operation. According to present estimates, that will take at least a year, so the prospects for the immediate future are not promising, unless imports can be obtained to fill what is estimated to be a 50 per cent shortfall in requirements. The unsatisfactory character of the position is further reflected in the comparatively wide range of prices of steels of the same grade offered from different overseas sources.

Industrial and Labour Notes

"Industrial Democracy" in the Gas Industry

During the debate in Parliament last week on the third reading of the Gas Bill, the Parliamentary Secretary to the Ministry of Fuel and Power, Mr. A. Robens, drew special attention to the provision made in the Bill for joint consultation at every level in the gas industry. He said that the important question of industrial democracy, as it was now termed, must be regarded as a great experiment. It had to be approached by those responsible for management with the proper conception of the rights of the workers in industry to put forward views and opinions which should be received in the proper spirit of co-operation between management and worker.

On joint consultative committees, Mr. Robens continued, the workers had to recognise a great change and had to appreciate their additional responsibility when industrial democracy was at work. Ideas and views had to be translated by managements into practical propositions, and "airy-fairy" theories could have no place at all round the consultative committee's table. The hard facts of technical, commercial and administrative life must be faced. Mr. Robens said that he wanted the workers in the gas industry to see very clearly the economies effected by greater efficiency increasing the value of man-hours so as to enable the industry to provide those measures of improved standards that workers were entitled to expect. The workers, he emphasised, must face up to the fact that there was no bottomless purse held by the Government out of which improved wages and conditions could be met. The publicly owned industries must stand on their own feet.

Taxation and Public Administration

In a speech at the annual meeting last week of the Liverpool branch of the National Union of Manufacturers, Sir Patrick Hannon referred to the crushing burden of taxation which weighed at present upon every phase of enterprise. He said that the present high rate of taxation was particularly disastrous since the sellers' market had practically disappeared and acute competition had taken its place in almost every country upon which we depended for our export trade. There were many difficulties and frustrations over manpower, materials, and transport, but the outstanding consideration, Sir Patrick asserted, was the weight of taxation which straddled and threatened to strangle every branch of enterprise.

Another factor, Sir Patrick commented, which was helping to restrict this country's industrial recovery was the swollen proportions of the public administration, both national and local. The fantastic position had now been reached that one employed person in every nine was engaged in checking the activities of the other eight. That, he suggested, was an intolerable state of affairs at any time, and particularly so when we were fighting desperately for our very survival as an industrial nation. No business, Sir Patrick declared, could stand such an overhead, and if, as a nation, such reckless extravagance was persisted in, a very heavy price might have to be paid for our folly in the not distant future.

Initiation Training

The British Association for Commercial and Industrial Education is to hold a one-day conference on Friday, July 2nd, at the Goldsmiths' Hall, Foster Lane, London, E.C.2, on the aims of initiation training. The speakers will include Sir Charles Tennyson, who is the chairman of the Federation of British Industries Education Committee; Lord Forrester, Mr. Charles Gillett, Miss Beryl Foyle, Mr. H. Watton Clark, and Mr. J. Paynter. It is felt that to gain the utmost possible co-operation between management and men throughout industry and commerce, and to promote better industrial relations, all grades must be kept fully informed on the needs, problems and organisation of the undertakings by which they are employed. The conference, it is hoped, will provide an opportunity for an effective exchange of views and ideas between all who are concerned with the subject of initiation training.

Tickets for the conference are 15s. each and may be obtained from the British Association for Commercial and Industrial Education, 107, Baker Street, London, W.1.

Shipbuilding Wages

It was announced on Friday last that the Shipbuilding Employers' Federation had rejected the wages claim put forward by the Confederation of Shipbuilding and Engineering Unions on behalf of shipbuilding and repairing workers in the United Kingdom. About 200,000 workers are involved, and the claim asked for the introduction of a national minimum consolidated rate of £5 19s. a week for skilled men and £5 a week for unskilled men, with corresponding advances in the wages of intermediate grades and piece workers.

In stating the Shipbuilding Employers' Federation's decision, Sir Wilfrid Ayre, the president, said that full consideration had been given to the claim, but it was felt that no advance was justified. Sir John Stephenson, on behalf of the unions concerned, expressed disappointment over the reply, and intimated that the matter would now be discussed by the Confederation.

British Exports to South America

An International Exhibition of Industry and Commerce is to be opened in Rio de Janeiro on July 10th. This exhibition is to be of a permanent nature, as arrangements have been made for it to operate for a period of ten years, and British firms interested in exporting their products to South America are invited to participate. In addition, the exhibition will constitute a "merchandise exchange" and all purchasing and sales transactions can be made through its trade bureau.

The exhibition is to remain open seven days a week throughout the year, each year being divided into seven exhibiting periods of fifty days, and the intention is to allocate space in the various halls of the exhibition in such a way as to group together products of a similar kind. It will not be possible to place heavy machinery exhibits in the halls, but adequate arrangements are being made for them on a suitable outdoor space.

British manufacturers who may be interested in this International Exhibition of Industry and Commerce may obtain all details from the United Kingdom representative, Mr. A. de Lasta, 86, Piccadilly, London, W.1. The organisers point out, of course, that although the exhibition is to be established in Brazil, the goods shown will be brought to the notice of the whole South American continent.

British Overseas Trade

Exports of United Kingdom goods in the month of May were valued at £129,923,006, the highest figure recorded this year. Allowing for the increase in prices, the volume of exports in May—in which there were only twenty-five working days owing to the Whitsun holiday—is provisionally estimated as being 134 per cent of the 1938 monthly average.

Machinery exports again made the largest contribution to the month's total, and amounted to 74,392 tons, valued at £21,153,100. Vehicle exports also continued at a high rate during May, the number of private cars and chassis reaching 20,375, while exports of commercial vehicles totalled 5704. Locomotive exports included 47 main line and 72 light engines. Exports of iron and steel and manufactures thereof totalled 162,249 tons in May, and exports of coal rose to 966,835 tons, a quantity nearly one-third of the 1938 monthly average.

Imports during May were valued at £176,000,162, a figure approximately £9,000,000 below that recorded in April, and re-exports were valued at £5,646,648. The adverse trade balance therefore declined during May to £40,430,408, compared with a monthly average over the first five months of 1948 of £42,500,000. The monthly average of the adverse balance of trade during 1947 was £49,300,000.

London Dockers' Strike

An unofficial strike of London dock workers started at the beginning of last week, and in the early part of this week it was stated that approximately 19,000 of the total labour force of 27,000 had become involved in it. This stoppage of work is alleged to be a protest against a decision of an accredited tribunal under the Dock Labour Scheme on disciplinary action concerning eleven men who refused to accept the special agreed rate for the unloading of zinc oxide. A statement on the matter which the Minister of Labour made in the House of Commons on Thursday of last week emphasised that the benefits of the Dock Labour Scheme carried with them obligations on the part of all concerned, and the hope was expressed that the strikers would realise those obligations and return to work forthwith.

The strike has, however, continued into the present week and has consequently seriously delayed the loading and unloading of a great deal of London's shipping. On Tuesday, a private meeting of members of the Transport and General Workers Union was held in the Albert Hall. It was addressed by Mr. Arthur Deakin, the general secretary, and it was reported afterwards that a resolution in favour of returning to work was carried. A rival meeting, however, convened in Victoria Park by the strike organisers, is said to have been in favour of continuing the strike. In the House of Commons on Tuesday afternoon, the Prime Minister, in answering questions, said that the Government looked to the men to recognise their obligations to resume work immediately, as a continuation of the strike would have serious effects on the national economy. As these notes go to press, there are indications that some of the strikers will return to work, but it is not at all clear that the decision taken by the Transport and General Workers' Union will be fully honoured.

Engineering Wages

The full text was issued last week of the reply made by the Engineering and Allied Employers' National Federation to the wage claim submitted on April 14th by the Confederation of Shipbuilding and Engineering Unions. The claim was for a national minimum consolidated rate of £5 15s. a week for skilled workers in the engineering industry, and of £5 a week for unskilled workers, with *pro rata* adjustments in the wages of intermediate grades, and the maintenance of existing differentials.

The employers' reply was presented by Sir Alexander Ramsay, Director of the Federation, who pointed out that the wage adjustments asked for would cost the Federated Employers alone an aggregate sum of many million pounds per annum. To add to the cost of production, to put up the price of exports, and as an inevitable consequence the cost of imports, was, Sir Alexander said, surely not the right approach. The present sense of insecurity relating to inflationary tendencies was far from baseless in the mind of every person concerned with affairs. The wage structure of the engineering industry, he asserted, was not the invention of the last year or two, but was the steady development of fifty years or more. Its most important feature was that it gave to the general run of workers in the industry a standard of earnings which compared favourably with any industry, and was far ahead of most.

French Engineering News

(From our French Correspondent)

The attention of metallurgists has been drawn to the presence, in the Lorraine iron ore, of metals such as vanadium and zinc. Although the amount of zinc is small, between 0·03 per cent and 0·04 per cent, the tonnage of ore available makes the extraction of this metal economically interesting. Applying agglomeration methods used for ore to the dust produced after cleaning, products containing between 0·5 per cent and 0·6 per cent zinc can be obtained. A highly inflammable dust containing up to 35 per cent zinc is also obtained following dry or electric filtering of blast furnace gas. Tests have been made with this dust, which cannot be transported over long distances owing to the danger of fire involved, but so far no definite results have been obtained. However, a process has been tried with success, the determining factor being the extent of the surface capable of being oxidised. The dust obtained using this process is about 1 per cent of the iron produced and if the average zinc content is 25 per cent, this would give for an annual production of blast furnaces equal to 500,000 tons of iron, 5000 tons of dust, containing 1250 tons of zinc.

* * *

The Maisons-Alfort Central Hydraulic Laboratory, near Paris, was recently officially opened by the Prime Minister, Monsieur Robert Schuman. Its work is concerned with hydraulic researches on port and river control, and the study of irrigation. The laboratory was completed after four years of construction. A large and small channel will permit locks and weirs to be studied and another channel will be used to study the formation of ice. Many studies are now being carried on at the laboratory, and some have already been completed.

* * *

The Federation of French Engineering Associations and Societies is to devote two days to various studies, in the course of which the role of engineers in the reconstruction and recovery of the country will be underlined. An attempt will be made to set out the different aspects of efficient collaboration of engineers with public authorities. The Federation represents thirty-eight engineering societies, with a total of 72,000 members. The two study days are to be held next November.

* * *

A reduction in the price of certain steel products is expected following the recommendations of a delegation of the Economic Council. Although it is possible that an increase in the price of coal may result in a 6 per cent increase in steel prices, the Government wishes to reduce the price of certain steel products by between 5 and 10 per cent. This is expected particularly to affect agricultural machinery, automobiles, ironmongery and users of tinplate.

* * *

Plant for the manufacture of tungsten carbide is under construction by the Ets. Scheider et Cie, at Creusot. Production will start at the beginning of next year. The Ugine steel works is also to produce tungsten carbide at its plant at Fontaine, which will specialise in the production of powdered metal. A modern electric furnace has been installed at the Usines de Fives-Lille. The work there includes the manufacture of shunting locomotives, travelling cranes, and hydraulic turbines for hydro-electric plant, such as a 90,000 h.p. turbine for Génissiat and a 70,000 h.p. turbine for Donzère Mondragon.

* * *

Monsieur Jean Monnet has presented his second report on the results of the modernisation and equipment plan in 1947. Among the basic industries, figures for electricity, petrol and oil and inland water transport were greater than the totals fixed by the plan. The others (coal, steel, cement, railways) are still below, whilst tractor construction was only one third the number envisaged. Equipment expenditure amounting to 470 milliard francs had been envisaged and 460 milliard francs were actually spent, which, taking into consideration the rise in prices, represents a 16 per cent shortcoming.

Notes and Memoranda

Rail and Road

ROAD HAULAGE REGULATIONS.—As part of the machinery for bringing into operation Part III of the Transport Act, 1947, which relates to road goods transport, the Minister of Transport has made Regulations covering the serving of notices for the acquisition of vehicles, compensation payments not exceeding £2000 in cash, and the fixing of operating centres for goods vehicles which will be affected by future restrictions on long-distance carriage of goods. The three groups of Regulations, all of which come into operation on July 1st, are the Road Haulage Undertakings (Notices of Acquisition, &c.) Regulations, 1948, which prescribe the forms of notice of acquisition to be used, and the times within which the notices must be given by the British Transport Commission; the Road Haulage Undertakings (Payment of Compensation) Regulations, 1948, which fix the period within which an operator may require the British Transport Commission to pay compensation in cash up to £2000 in respect of an undertaking compulsorily acquired, and the Goods Vehicles (Operating Centre) Regulations, 1948, which prescribe the forms to be used by road goods transport operators for requests to Licensing Authorities for Goods Vehicles to specify operating centres for goods vehicles, and the periods within which these requests can be made. The operating centre is the point from which the circle of 25 miles radius will be drawn, outside which goods may not, after the day to be appointed by the Minister, be carried for hire or reward except under permit from the British Transport Commission. Copies of the Regulations can be obtained from H.M. Stationery Office.

Air and Water

SHIPPING SUBSIDIES.—The Minister of Transport states in a written reply that subsidies towards the cost of maintaining the steamship services between the Western Highlands and Islands amount to approximately £14,500 a month. To enable liner freight rates in the coastwise trades to be maintained in reasonable relationship with railway rates, payments are made to the shipping lines concerned, totalling about £41,500 a month.

"PORTS OF THE WORLD."—A new edition of "Ports of the World," edited by Sir Archibald Hurd, has been published recently. It includes information about every port and harbour of commercial importance in the world. The details given cover such items as imports and exports, depths of water, quayage, docks, loading and discharging facilities, bunkering and ship-repairing facilities, railway connections and port charges. A new and very useful addition is sixteen pages of maps. The book is published by The Shipping World, Ltd., Effingham House, Arundel Street, London, W.C.2, price 30s.

A LIFE-SAVING FLOAT.—The Admiralty has stated that a new type of life-saving gear, incorporating a circular rubber float and tent, is to be given sea trials by the Royal Navy. It has been developed by a standing Admiralty committee formed to deal with the design and material aspects of survival of those adrift at sea after being forced to abandon ship. The float, known as type J.S., is a development of the J. type aircraft dinghy, and when inflated it resembles a huge motor tyre fitted with a rubberised fabric floor and covered by a tent. An inflated cushion provides a dry seat insulated from the cold temperature of the sea, and other features are a container for food and water, visual and radar aids to location, a baler, sponge, paddles, a drogue, and a bellows for inflating the cushions and topping up buoyancy chambers. The radar aid consists of a reflector at the head of the telescopic mast. The float is designed to provide shelter for ten men and will support them if only half inflated. It is normally stowed in a deflated state in a valise, along with the equipment mentioned above, the total weight being 200 lb. The float is inflated by pulling a lanyard which releases carbon dioxide from a bottle. As it expands, the float rips open the valise and the gear is ready for use in a few seconds.

Miscellanea

WELDING DESIGN COMPETITION.—The Council of the Institute of Welding has awarded the prize in the competition for the design of a work piece to Mr. R. A. Iddon, senior planning engineer in the medium plate shops of G. A. Harvey and Co. (London), Ltd. Mr. Iddon's design, which will be published in the "Transactions" of the Institute, is for a welded box, to be tested to destruction under hydraulic pressure.

MARKET RESEARCH.—Last October, the Manchester Joint Research Council arranged a conference on the subject of "Market Research." Papers were presented dealing with the technique of market research and the investigation of consumer requirements. A full account of the proceedings at the conference has now been published and is available, price 2s. 6d., from the Secretariat of the Council, Ship Canal House, King Street, Manchester, 2.

"ROYAL DESIGNERS FOR INDUSTRY."—The first exhibition of the work of Royal Designers for Industry is to be held at Burlington House, Piccadilly, London, by permission of the President of the Royal Academy, during next October. The exhibition is being organised jointly by the Royal Society of Arts and the Council of Industrial Design, its object being to show, by practical demonstration and example, the commercial importance of good design and the vital contribution to industry which designers are making.

A NEW CAR TYRE.—A new design of motor-car tyre has been announced by the Dunlop Rubber Company, Ltd. It has a flatter and deeper tread than existing tyres, and the tread pattern incorporates more teeth and knife cuts, so giving increased mileage and improved resistance to skidding, amounting, it is claimed, to a 15 per cent improvement in each case. The tyre will be available in "Fort" and "Standard" qualities, the former incorporating a special carbon black, which has the property of dissipating static electricity, so reducing interference with car radio reception. As a result of variable pitch in the tread pattern the tyre is said to run silently throughout its life.

INSTITUTION OF ELECTRICAL ENGINEERS CONVERSAZIONE.—The annual conversazione of the Institution of Electrical Engineers was held at the Science Museum from 8 to 11 p.m. on Tuesday, June 22nd. Members and guests were received by the President, Mr. Percy Good, C.B.E., Mrs. Good, and the Council of the Institution. During the evening the company was entertained by a vocal and instrumental concert, and music was provided by the orchestra of the Royal Corps of Signals. A short film entitled "Pioneers of Science," was shown in the lecture theatre. Exhibits on the ground floor and the first, second and third floor galleries, including the special exhibition, "Darkness into Daylight," were open to the guests, who were able to see the progress made in the formidable post-war task of restoring the collections.

MULLARD-HALLICRAFTERS TRADE AGREEMENT.—Mullard Electronic Products, Ltd., have concluded an agreement with Hallicrafters Incorporated of Chicago, the amateur communications receiver and transmitter designers, whereby Mullards have the right to manufacture all Hallicrafter communication designs. In addition Mullards will be responsible for the representation of Hallicrafters in the U.K., Eire, and Australasia; this being separate from their world rights as Mullards. One of the first models that will be released under this arrangement is the Hallicrafter SX 42 communication receiver, which gives coverage from 0·5 to 110 Mc/s with frequency modulated reception from 50 to 110 Mc/s. Enquiries should be addressed to Mullard Electronic Products, Ltd., Communications Division, Century House, Shaftesbury Avenue, London, W.C.2.

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON STUDENTS' SECTION.—The report of the I.E.E. London Students' Section Committee for the session 1947–48 shows that the present membership is 3534, comprising 2406 students and 1128 graduates under twenty-eight years of age. Five full-length papers, including the chairman's address, have been presented by members of the section. The two "Problems Nights" were well attended. An interesting meeting was the address entitled "The General Aspects of Standardisation," which was delivered to the section by the president, Mr. P. Good, C.B.E. Throughout the session the average attendance at meetings was ninety-five, representing 2·7 per cent of the section membership. Nineteen visits were made to various establishments, including newspaper offices and film studios. Of more technical interest were visits to the Battersea generating station and the C.E.B. Central Control Room. Co-operation with kindred bodies has been extended and arrangements have been made for forty members drawn from all Students' Sections of the I.E.E. for a summer tour of Switzerland. The party will visit industrial plants and installations, including the works of Brown Boveri (Baden) and Oerlikon (Zurich), the gas turbine power station at Beznau and the underground power station at Innertkirchen.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Building Technicians

Monday, July 12th.—Committee Room 140, L.C.C. County Hall, S.E.1. "Planning and Reconstruction in Poland," Arthur Ling. 5.30 p.m.

Incorporated Plant Engineers

Monday, June 28th.—LEEDS BRANCH: Mines Department, The University, Leeds. "Ball and Roller Bearings," J. L. Potts. 7.30 p.m.

Institution of Sanitary Engineers

Friday, July 2nd.—National Club, 12, Queen Anne's Gate, S.W.1. Annual General Meeting. 5 p.m.—Caxton Hall, S.W.1. "The Colne Valley Sewerage Scheme," W. Fillingham Brown. 6 p.m.

Saturday, July 3rd.—Visit to the Maple Lodge Works of the Colne Valley Sewerage Board. 11 a.m.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of report	Title	Post free s. d.
F.I.A.T.		
1311	The Manufacture of Ethylene Glycol, Polyglycols, Glycol Ethers, Ethylene Cyanhydrin and Acrylonitrile, Phenyl Ethyl Alcohol and Related Derivatives of Ethylene Oxide in Germany	7 8
T/ BT-6 ...	Wind-Tunnel Tests of Short Single and Multiple Transmission Conductors...	0 3
T/B T-21 ...	Chromium Plating at Siemens and Halske A.G., Berlin, Germany	0 3
T/B T-23 ...	Seomag Processes for the Production of Corrosion Resistant Coatings on Magnesium Alloys	0 3
F.I.A.T.		
T/B T-26 ...	Preparation and Application of Albert Glue 319 J	0 3
T/B T-38 ...	The Preparation of Oil-Soluble Phenol-Acetylene Resins for use in Surface Coatings	0 3
T/B T-54 ...	Postonal, a Water Soluble Wax for Pharmaceutical Preparations	0 3
B.I.O.S.		
JAP/PR/843	The Aluminium and Magnesium Fabricating Industries in Japan Proper	1 4
B.I.O.S.:		
1398	Investigation of German Heavy Forging Plants	20 4
1721	The Use of Prestressed Concrete in Germany	15 3
1740	Cellulose Acetate, Cellulose Tripropionate and Cellulose Acetate Butyrate. Interrogation of Drs. Rohm, Ziegler, Schneg, of I.G. Dormagen	1 7
F.I.A.T.:		
810	Activated Clay Bleaching Absorbents	2 7
B.I.O.S.:		
Misc. 66 ...	German Infra-Red Driving and Fire-Control Equipment	5 7
1659	German Measuring Instruments and Machines used in Precision Engineering...	14 4
1743	The German Superphosphate Industry	17 10
1749	German Synthetic Detergents, Interrogation of Dr. W. E. Lange, of Bohme Fettchemie and Henkel and Cie, Dusseldorf and Chemnitz	2 8
Misc. 82 ...	Dutch Report on Visit to Refractory Brick Factories in the American and French Zone of Germany	2 2
C.I.O.S.:		
E/R 16 ...	I.G. Farbenindustrie A.G. Ludwigshafen-Oppau, Fuels and Lubricants Testing and Development	3
E/R 214 ...	Ringsdorff-Werke, K.G., Mehlem am Rhein, Industrial Carbons...	3
E/R 269 ...	Report on Siemens Schuckert, Pretzeld, The Schloss, N.E. of Eachheim	3
E/R 303 ...	Report on Electrical Side of Friedrich Krupp A.G., Schiessplatz, Meppen	3
E/R 380 ...	The German Emergency Flying Suit	3
B.I.O.S.:		
1512	German Brewing Industry ...	14 4
1611	Major Developments in Synthetic Lubricants and Additives in Germany	15 0
1735	German Optical Machine Tools...	2 7
1754	Melamine Production, Mainkur...	2 8
1757	Manufacture of Super-Purity Aluminium at the Vereingte Aluminium Werke, Erftwerk, Grevenbroich	5 2
F.I.A.T.:		
1053	Aeration System in the Continuous Waldhof Food Yeast Process	3 8
1301	Supplemental Report on Applications of Diisocyanates	1 7
B.I.O.S.:		
Misc. 80 ...	Dutch Report on Steel Tube making in Germany	3 2
Misc. 81 ...	Dutch Report on the German Cycle and Cycle Components Industry	3 2
1269 ... ... (Addendum)	Test Gear for Frequency Modulation and Television	1 1
1634	Manufacture of Sulphuric Acid, Fabrik Schlebusch der Dynamit A.G. Vormals Alfred Nobel and Co., Leverkusen-Schlebusch ...	3 2
1728	Thermal Measuring Instruments	3 8
F.I.A.T.:		
764 (In 4 volumes)	Dyestuffs Manufacturing Processes of I.G. Farbenindustrie A.G. This report is an index of the Dyestuffs manufactured by I.G. Farbenindustries, the manufacturing details of which are recorded on microfilm:	
	Volume I	8 9
	Volume II	9 3
	Volume III	7 2
	Volume IV	7 9
B.I.O.S.:		
Misc. 78 ...	Dutch Report on Visit to Refractory Brick Factories in the British Zone of Germany... ...	2 7
Misc. 79 ...	Dutch Report on different Subjects in the Steel and Metal Industry	5 2

Technical Information and Documents Unit, German Division, Board of Trade, 40, Cadogan Square, S.W.1, which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

Catalogues

F. J. EDWARDS, Ltd., 359–361, Euston Road, N.W.1. Catalogue of swaging machines.

CARTWRIGHT, Ltd., Henshaw Works, Oldham. Folders describing range of paints and varnishes.

HYLAND, Ltd., Doncaster Road, Wakefield. Brochure describing hydraulic oil pumps and motors.

METALASTIK, Ltd., Evington Valley Road, Leicester. Additions to the handbook, "Technical Information."

BRONX ENGINEERING COMPANY, Ltd., Lye, Near Stourbridge. Catalogue of all-steel welded press brakes.

MORGAN CRUCIBLE COMPANY, Ltd., Battersea Church Road, S.W.11. Pamphlet on tilting, lift-out and bale-out furnaces.

AVELING-BARFORD, Ltd., Grantham. Publication No. 1511, describing and illustrating trench cutting machines.

COVENTRY DIESEL ENGINES, Ltd., Friars Road, Coventry. Illustrated booklet entitled "The 'Godiva' Marine Diesel."

PHILIPS ELECTRICAL, Ltd., Century House, Shaftesbury Avenue, W.C.2. Illustrated folder dealing with mercury lighting.

WAILES DOVE BITUMASTIC, Ltd., Hebburn, Co. Durham. Booklet entitled "The Prevention of Corrosion and Kindred Subjects."

DAVEY AND UNITED ENGINEERING COMPANY, Ltd., Park Iron Works, Sheffield. Illustrated booklet dealing with heavy engineering products.

BUTTERLEY COMPANY, Ltd., 2, Caxton Street, S.W.1. Brochure illustrating the activities of the company's constructional engineering department.

ARTHUR BALFOUR AND CO., Ltd., Capital Steel Works, Sheffield, 3. Brochure describing "Balfalloy" hard metal tipped rotary boring bits for coal and stone.

END OF VOL. CLXXXV

Personal and Business

MR. I. W. D. MACDOUGALL has been appointed a director of Mavor and Coulson, Ltd.

MR. T. W. HAYES has been appointed export manager of A. C. Wickman, Ltd.

MR. H. W. JAMIESON has joined the London sales staff of Bull Motors (E. R. and F. Turner, Ltd.), Ipswich.

LLOYD'S REGISTER OF SHIPPING states that Sir Ronald Garrett has been re-elected chairman of the General Committee.

MR. H. D. B. WOOD, an assistant secretary of the Board of Trade, has been appointed Secretary of the South-Western Electricity Board.

THE ELECTROPLANT COMPANY, Palace of Engineering, Wembley, announces that its telephone number has been changed to Wembley 6061 (six lines).

MR. N. F. SPENCE has been re-elected President of the British Cast Concrete Federation. Mr. R. H. Bates has been elected chairman and Mr. M. Girling vice-chairman.

MESSRS. RENDEL, PALMER AND TRITTON, announce that from June 25th their address will be 125, Victoria Street, Westminster, S.W.1 (telephone, Victoria 8494).

HAWKER SIDDELEY AIRCRAFT COMPANY, Ltd., states that the address of its sales co-ordination department is now 18, St. James's Square, London, S.W.1 (telephone, Whitehall 2064).

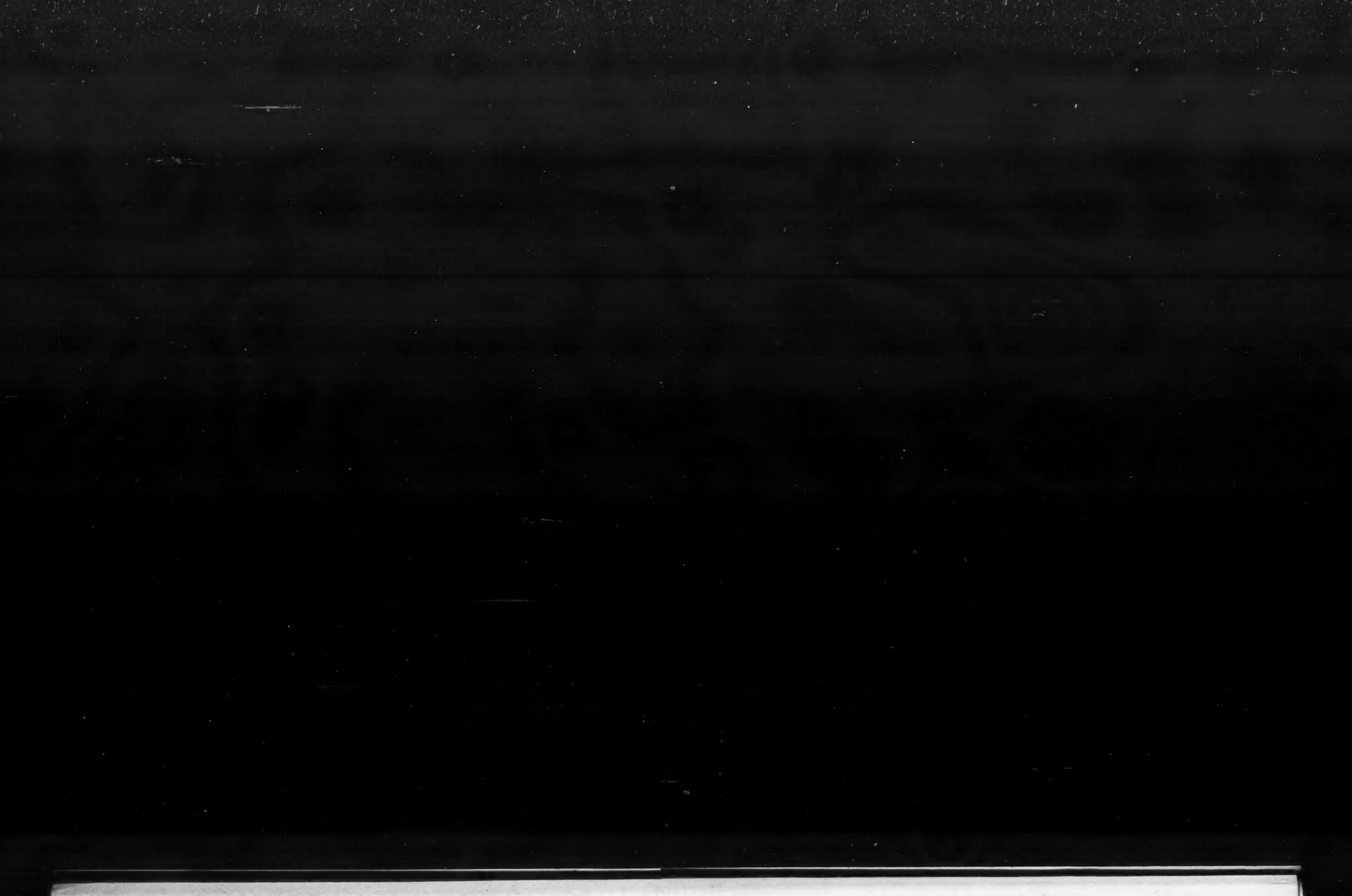
BRITISH RAILWAYS announces the following appointments: Mr. J. Royston, assistant operating superintendent, Eastern Region, and Mr. M. G. Maycock, district engineer, Eastern Region, King's Cross.

THE COLONIAL OFFICE announces the following appointments: Mr. J. J. Howard, assistant engineer, Public Works Department, Sarawak; Mr. D. A. G. Allan, assistant engineer, Public Works Department, Kenya; Mr. P. A. Hanton, assistant engineer, Tanganyika Railways, and Mr. A. S. Webb, assistant engineer, Nigerian Railways.

Contracts

THE BRITISH ELECTRICITY AUTHORITY states that during the past month contracts have been placed for generating station, switching and transforming station and transmission equipment amounting in the aggregate to £2,575,505.

SCIENTIFIC ADVISORY COUNCIL.—The Ministry of Supply announces the following appointments to the Advisory Council on Scientific Research and Technical Development, which advises on the important scientific and technical problems with which the Ministry is concerned:—Sir Howard Florey, F.R.S., Professor of Pathology, Sir William Dunn's School of Pathology, Oxford; Professor J. L. M. Morrison, M.I.Mech.E., Professor of Mechanical Engineering, Merchant Venturers' Technical College, Bristol, and Professor L. Rosenhead, D.Sc., F.R.S., Professor of Applied Mathematics, Liverpool University.

THE REFINING OF METALS.—The Council of the Institution of Mining and Metallurgy has decided to arrange for a symposium on the refining of non-ferrous metals to be held in London in the summer of 1949. The symposium will occupy the two days July 7 and 8, 1949 (Thursday and Friday of the week preceding the Fourth Empire Mining and Metallurgical Congress). The papers to be presented will be issued as preprints, so that most of the time available at the meeting may be devoted to discussion. Prospective authors and others who are interested in metal refining are requested to communicate with the Institution of Mining and Metallurgy, Salisbury House, London, E.C.2.

FOREIGN MEMBERS OF THE ROYAL SOCIETY.—At a recent meeting of the Royal Society, the following were elected foreign members of the Society:—Dr. Detlev Wulf Bronk, Philadelphia, Foreign Secretary of the National Academy of Sciences of the U.S.A. and Chairman of the National Research Council; Professor Luitzen Egbertus Jan Brouwer, Amsterdam, Professor of Mathematics in the University of Amsterdam and a member of the Koninklijke Nederlandsche Akademie van Wetenschappen; Professor Maurice Jules Gaston Corneille Caullery, Paris, Professor in the Faculty of Biological Science, Paris University; and Professor Linus Carl Pauling, Pasadena, Professor of Chemistry at the California Institute of Technology.